THURSDAY, OCTOBER 19, 1899.

ELECTRO-MAGNETIC THEORY.

Electro-magnetic Theory. Vol. ii. By Oliver Heaviside. Pp. xvi + 542. (London: The *Electrician* Co., Ltd.)

THIS interesting work, the first volume of which appeared some five years ago, well sustains Mr. Heaviside's reputation as an original investigator, and even when we do not agree with his procedure, we must admire his fertility of resource and the skilful manner in which he develops his methods. Although we are more than once warned that the treatment is not formally or logically arranged, as is indeed the case, Mr. Heaviside has nevertheless, in essentials, admirably arranged his matter, so that we are led on by gentle steps from comparatively simple to more complex problems.

The book may be regarded from two distinct points of view. Firstly, without inquiring too closely into the validity of the mathematical methods employed, we may consider the work from a physical point of view as a mathematical theory of the propagation of plane electro-magnetic waves in conducting dielectrics, according to Maxwell's theory, or as the theory of the propagation of waves along wires. Secondly, we may consider the book from a purely mathematical point of view as an introduction to the theory of generalised differentiation, divergent series, and Bessel's functions, viewed, however, for the most part through physical spectacles.

The book opens with a discussion of the age of the earth, in which Prof. Perry's results are explained and contrasted with those of Lord Kelvin. Then follows a discussion of the equations

$$-\frac{dV}{dx}=RC, \qquad -\frac{dC}{dx}=Sp V$$

where V and C are the voltage and current, R and S the resistance and permittivity per unit of length, and p stands for $\frac{d}{dt}$. A large number of problems are considered in some detail, and it is very noticeable how easily terminal conditions are dealt with by Mr. Heaviside's methods, and in this respect they have a great advantage over Fourier's method. The more general equations

$$-\frac{dV}{dx}=(R+Lp)C, \qquad -\frac{dC}{dx}=(K+Sp)V$$

where L is the inductance and K the leakance, as Mr. Heaviside terms it, per unit of length, are next considered. These in the case where 1/R, 1/L, K and S all vary as the nth power of the distance from $x=0$ lead to Bessel's functions. As before, a great variety of interesting and important questions are dealt with, and Mr. Heaviside is careful to explain that these are not mere mathematical exercises, but that the formulæ apply to cylindrical electro-magnetic waves. The case of R, L, K, S, constants is discussed at some length, and owing to the application of the results to practical questions concerning telegraph and telephone cables they should be kept in mind by "practicians." Mr. Heaviside has for long been preaching in the wilderness on this matter, but his labours will bear fruit one day, and we trust that when the day comes it will not be a case of "tulit alter honores," as has happened to other men in other matters. Some sections are devoted to discussions of the experiments of Dr. Barton and Dr. Bryan, of spherical waves, and, with some reserve, to the experiments of Hertz and Lodge. The sections on spherical waves have, as is pointed out by the author, a practical application in wireless telegraphy. Some rough, but interesting, curves showing the progress of a wave under various circumstances conclude the physical portion of the work.

Passing on to the mathematical aspect of the book, operational methods are freely employed, and their reduction to algebraical form leads us at an early stage of the work to the question of fractional differentiation. This is a subject which has frequently occupied the attention of mathematicians, and two main modes of proceeding have been proposed, one taking e^x, the other x^n as the fundamental symbol; the first method was employed by Liouville and Kelland, the second by Peacock. Both methods find formulæ which are certainly true when the index of the operating symbol is an integer, and for the case of the index or fraction both appeal to the principle of the permanence of algebraical forms. If both methods produced the same result in every case all might be well, but most unfortunately this is not so, at least without some further assumption, and it is a question beset with difficulties which system, if either, is to be considered the true one. Mr. Heaviside's method evades rather than elucidates the difficulties. He requires to find the value of $p^{\frac{1}{2}}1$, where $p=\frac{d}{dt}$, and 1 is that function of t which is zero before and unity after $t=0$. To effect this he takes a suitable physical problem, and, solving symbolically, obtains a solution involving $p^{\frac{1}{2}}1$; then by another method he finds a solution free from operators; a comparison of the two gives $p^{\frac{1}{2}}1=(\pi t)^{-\frac{1}{2}}$. This is the same value as is given by Peacock's method, but not that which is given by Liouville's and Kelland's without further assumption. In Chapter vii. another way, on the same lines as before, is given of finding this result, and the remark is added, "I do not give any formal proof that all ways properly followed must necessarily lead to the same result." It is much to be regretted that no hint is given on this point, for, granting that there is a theory of fractional differentiation, the way to be properly followed is the essence of the whole matter.

Some of Mr. Heaviside's methods of dealing with series in Chapter viii. are also open to some objection; he more than once tests the equivalence of two series by giving the variable numerical values and seeing if the two series give the same result. This may be an "excursion to the borders of the realms of duplicity," but scarcely to those of "fearful rigour." It would seem, indeed, from many passages in the book, that Mr. Heaviside considers rigour in mathematics to be of somewhat minor importance; for instance:

"You have first to find out what there is to find out. How you do it is quite a secondary consideration."

If this advice were to be generally followed, mathematicians would no doubt jump many gates in their endeavours to reach the goal on the other side, but whether or no they would not at times land in a quagmire may be open to doubt.

Mr. Heaviside's treatment of Bessel's functions is interesting and suggestive, but the lack of formal arrangement is here severely felt; it is not always easy to distinguish clearly between what is proved and what is experimentally assumed to see how it goes as Mr. Heaviside puts it. The student who is previously unacquainted with the properties of these functions will probably find difficulty in following some of the equations written down without proof. In the equation for $K_0(qx)$, p. 226, for example, all the information given about γ (Euler's constant, but not distinguished as such) is "where $\gamma = 0{\cdot}5772$ is a certain constant introduced to make $K_0(qx)$ vanish at infinity"; certain of the conjugate relations are also without proof, but these possibly are left as exercises for the student.

The work is nevertheless one which will well repay careful attention. As has been remarked by Prof. De Morgan:

"The history of algebra shows us that nothing is more unsound than the rejection of any method which naturally arises, on account of one or more apparently valid cases in which such methods lead to erroneous results. Such cases should indeed teach caution, but not rejection."

Mr. Heaviside is much to be congratulated on the light he has thrown on difficult and perplexing questions in both physics and mathematics, and also for calling the attention of mathematicians to a powerful, but somewhat neglected, weapon. C. S. WHITEHEAD.

OUR BOOK SHELF.

Catalogue of the Lepidoptera of Northumberland, Durham and Newcastle-upon-Tyne. Part I. By J. E. Robson. *Nat. Hist. Trans. of Northumberland, Durham and Newcastle-upon-Tyne*, Vol. xii. Part 1. Pp. 195.

THE present instalment of this important catalogue includes the butterflies, together with such of the moths as are comprised in the *Sphingina* (hawk-moths), *Bombycina*, and *Noctuina*. In his classification the author thus far follows Mr. Barrett's monograph of the British Lepidoptera, to the unpublished portions of which he has been supplied with references by Mr. Barrett himself. Whatever faults there may be in the scheme of classification in question, and the nomenclature employed therein, the adoption of a uniform system by different writers is highly desirable; and we, therefore, consider that Mr. Robson has been well advised in the course he has adopted.

As the author has had the advantage of the co-operation of all the local collectors of repute, his work may be regarded as a thoroughly up-to-date account of the Lepidopterous fauna of the northernmost counties of England. And how different this fauna is from that of the midland and southern counties may be gathered from a glance at the portion devoted to the butterflies. The common Brimstone Butterfly, for example, is only known in the area treated of by two or three stragglers, its normal range not extending northwards of South Yorkshire. Much more remarkable, however, is the circumstance that certain species of butterflies, such as the Comma and the Red Admiral, which were once common in the two counties, have for the last forty years been extremely scarce, although the second of the two mentioned has once again become a familiar object since 1893. It would be interesting to know the reason why so many of these insects left the district during the sixties; but on this point the author is silent. On the other hand, as might perhaps have been expected, migratory species, such as the Clouded Yellow and the Camberwell Beauty, which visit England at uncertain intervals in larger or smaller numbers, commonly travel into the northern counties; the author remarking of the last-named insect that it "visits these counties on most of those rare occasions when a wandering horde strikes our shores." Of the moths, it must suffice to say that the Death's-head has occurred in both counties, and there is reason to believe has bred in them, but that the stock is probably maintained by immigration from the south.

The foregoing instances demonstrate that Mr. Robson's work is very far from being a mere dry catalogue; and that it really teems with interesting observations on the life-history and distribution of all the species recorded. If the sequel be maintained at the same high level, the complete catalogue ought to prove a very important contribution to entomological literature. R. L.

The Process Year-Book for 1899 ("Penrose's Pictorial Annual"). Edited by William Gamble. Pp. viii + 108. (London: Penrose and Co., 1899.)

THIS is the fifth year's issue of this most excellent review of the graphic arts, and the editor, together with all his co-workers, are to be congratulated on the production of such a handsome and interesting volume.

As in former years, most of the articles are written by those who are at work in some line of process work, and as these are by no means few in number, the reader is made acquainted with a great amount of experience which may help him to success in the future. The feature of the book is undoubtedly the beautiful illustrations, which bring home to the reader the high state of excellence that the art of reproduction has reached at the present day. All kinds of subjects, from a stellar cluster down to an orchid, are illustrated, and these serve as types for showing the results obtained by the working of different processes.

The high order of merit attained should not only render the book a valuable aid to the process worker and others interested in the art of reproduction, but should find many other friends who would delight to possess such a charming collection of high-class illustrations.

Mathematical Tables. By James P. Wrapson and W. W. Haldane Gee. Pp. 28. (London: Macmillan and Co., Ltd., 1899.)

THIS set of useful tables in a compact form are abstracted from the compilers' larger volume of "Mathematical and Physical Tables." The idea of this present issue is to place before students tables which are suitable for the class and laboratory, and which give sufficient accuracy for such computations.

To sum up the contents, we have four place logarithms and antilogarithms, natural sines, cosines, and tangents, with interpolation to 1′. Logarithmic sines, cosines, and tangents with differences also to 1′. Tables of squares, exponential functions, weights and measures, and finally a table of conversion for the last mentioned.

Opinions et Curiosites touchant la Mathématique. By G. Maupin. (Paris: Carré et Naud, 1898.)

THIS is a collection of curious ideas and essays, which the author has encountered in the course of much heterogeneous reading in ancient scientific works, in which there has been found any reference however remote to mathematical thought. Paradoxes and absurdities alone seem to be considered worth inclusion; the book is of little or no use as a contribution to the history of mathematics.

LETTERS TO THE EDITOR.

The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*]

Peripatus in the Malay Peninsula.

MY friend Mr. Richard Evans, of Jesus College, Oxford, now in the Malay Peninsula with the Skeat Expedition sent out by the University of Cambridge, writes to me that he and subsequently other members of the expedition have discovered Peripatus. His letter, written from Aring, Kalantan, and dated August 27, states that he had found two specimens about three months previously. The locality is given as "one of the mountains here." For some months after this discovery no further specimens were found, in spite of much searching. A little before the date of his letter, however, Mr. Laidlaw, of Cambridge, had found five and Mr. Evans six additional specimens, thus bringing up the number to thirteen.

The eleven specimens which were obtained last were found in two groups of five each, while a single individual was discovered by itself in the rotten tree in which one of the groups occurred.

The individuals of a group differed much in size, although each group was probably a brood.

The colour of the specimens is chocolate-brown above with numerous small pale spots, the under-surface being pinkish yellow with a nearly white spot between the feet of each pair.

The number of pairs of feet varies from twenty-three to twenty-five, the latter number occurring in the largest and presumably the oldest specimens.

Mr. Evans has asked me to embody these facts in a note to NATURE, and I feel sure that they will be of great interest to all naturalists. EDWARD B. POULTON.

Oxford, October 13.

Dark Lightning Flashes.

THE paper by Mr. A. W. Clayden, referred to in my lecture from which Dr. Lockyer quotes (p. 570 *ante*), is entitled "Note on some Photographs of Lightning and of Black Electric Sparks," and is to be found in the *Proceedings* of the Physical Society, vol. x. p. 180, having been read on June 22, 1889. The author's photographs were exhibited at the meeting, but were not printed with the paper.

The following extract shows that some of Mr. Clayden's observations were very similar to those described by Dr. Lockyer. He photographed some electric sparks of different intensities, "and before developing the plates exposed them to the diffused light from a gas flame. The brilliant sparks then yielded images which may either be called normal with a reversed margin, or reversed with a normal core. The fainter sparks were completely reversed. . . . The reversal seems to spread inwards as the exposure to diffused light is increased." If the section of a flash is approximately circular, the luminosity would naturally be greatest along the middle, gradually falling off towards the edge.

It was of course known long before the date of Mr. Clayden's paper that the bright parts of a photograph might be reversed by the action of diffused light before development (Sutton's "Dic. of Photography," edition of 1867, p. 299).

I think it hardly possible that any lightning flash would be sufficiently brilliant to give a photographic image with a dark core and bright edges—Nos. 5 and 6 of Dr. Lockyer's list. The image of the sun itself is not generally reversed, unless with comparatively long exposure. The picture in the *Strand Magazine* (vol. xiii. p. 44, Fig. 10), which I understand to be the only apparent example of this class of reversal which Dr. Lockyer has met with, seems to me, from considerations of perspective, to represent beyond question merely a close double flash, two connected discharges having taken the same path through a moving body of air.

Dr. Lockyer's convincing article has no doubt finally disposed of the dark flash as an objective reality. It is to be hoped that so-called "ribbon lightning" will soon follow in its footsteps. SHELFORD BIDWELL.

Heredity and Variation.

THE interesting suggestion made by Prof. Adam Sedgwick in his Dover address—to the effect that variability has decreased and heredity increased, so to speak, as evolution has progressed—leads me to call attention to the work of certain other writers. Prof. Bailey, of Cornell University, in his work "The Survival of the Unlike" (Macmillan) argues in detail for a similar view, *i.e.* that heredity has been gradually "acquired," while variability has been reduced. His book deals largely with evidence from plants. He stated the view earlier in certain papers. Moreover Prof. Williams, of Yale University, independently took up a like position at about the same time in several papers, the latest one having been read and discussed before the Society of American Naturalists at Ithaca, N.Y., December 1897, and subsequently printed in *Science*.[1] The point of view has become fairly familiar to American biologists. Indeed the editor of *Science* has referred to it as one of the two most important recent suggestions in the theory of evolution. As Prof. Sedgwick does not refer to these writers—though he may intend to do so in the fuller discussion which he promises—his readers to whom the suggestion appeals may find it worth while to look into them. The work of Prof. Bailey—who is a natural selectionist among botanists!—is remarkable from other points of view as well.

Oxford, October 10. J. MARK BALDWIN.

Phosphorescent Earthworms.

IN a recent issue of NATURE (during May of the current year) Mr. Beddard, in referring to the phosphorescence of *Microscolex* (*Photodrilus*) and of *Allolobophora foetida*, suggests that this phenomenon is exhibited by the slime secreted by the epidermis. Will you allow me to mention my observation on a New Zealand worm that indicates that the matter is worthy of re-investigation?

Our large white earthworm (*Octochoetus multiporus*) has a milk-coloured cœlomic fluid of very great tenacity; it can be drawn out into strands, and soon hardens on exposure to air. In the dark, when the worm is handled, this fluid is discharged abundantly from the dorsal pores and from the mouth, which it reaches through the "peptonephridia" opening into the buccal cavity. The fluid is brilliantly phosphorescent when freshly discharged, and the fluid sticks to one's fingers very persistently; but it soon loses its phosphorescence. I wish here merely to point out that the luminosity is due to the cœlomic fluid in *O. multiporus*, and I believe that further examination will show that the same is true of *A. foetida*.

The fluid in *O. multiporus* contains numbers of "elæocytes," which are present also in *A. foetida* and other European worms; but in the New Zealand worm they are colourless, not yellow. A very remarkable kind of corpuscle is also present, viz. a cell containing a threadlike structure not unlike those described by Goodrich in an enclytræid a few years back. I am now endeavouring to locate the phosphorescence—that is, to ascertain which of these two cells is the seat of the phenomenon.

Dunedin, N.Z., August 5. W. BLAXLAND BENHAM.

MEETING OF THE INTERNATIONAL METEOROLOGICAL COMMITTEE.

THE Committee met at St. Petersburg from September 2–7; the meeting was a small one, only about half of the members being present. It was opened by the Grand Duke Constantine, who delivered an interesting address, in which he specially referred to the service rendered to meteorological science by A. Kupffer, the founder of the Russian climatological organisation. The reports of the various sub-committees were read and considered, and the following are the principal resolutions arrived at:—On the report, by Prof. Rücker, upon terrestrial magnetism and atmospheric electricity, it was decided that the sub-committee should be maintained as a distinct organisation, under the direct supervision of the International Committee. In reply to a question by

[1] I regret that absence from my library makes it impossible for me to give the exact references to his papers and to Prof. Bailey's.

General Rykatcheff, director of the Russian Meteorological Service, the Committee recommended that meteorological institutions should take part in observations of earthquake phenomena. With regard to Antarctic exploration, the Committee expressed the opinion that it is highly desirable (1) that the results of these explorations should be completed by data from the observatories already existing in the southern hemisphere, and by those made on board vessels traversing the southern oceans; (2) that new meteorological stations should be established in the southern part of the Antarctic regions, and especially that magnetic observations should be organised; (3) that magnetic determinations over the whole globe should be made simultaneously with those made during the expeditions. With reference to the valuable researches of Dr. Hildebrandsson relating to the great centres of action of the atmosphere (which have already been noticed in our columns), the following resolution was adopted:—"The Committee appreciates the high interest attached to observations made in a regular manner in different regions which seem to possess special importance as to our knowledge of the general laws of the motions of the atmosphere." Profs. v. Bezold and Mascart drew attention to the proposed establishment of a very complete meteorological and magnetical observatory at the Azores by the Prince of Monaco, assisted by Captain Chaves, of the Portuguese navy, who has entirely devoted himself to the realisation of this undertaking. On the question of the calculation of daily meteorological means, it was decided that if the exact formula

$$\frac{0+24}{2}+1 \ldots +23:24$$

is not adopted the midnight observation should be taken into account at the end of the day, as is already done at most stations, according to the formula

$$1+2+3 \ldots +24:24.$$

On the proposal of Dr. Hann to publish tables of diurnal range of temperature for each country in a special form, the Committee, while appreciating the interest and importance of the proposal, expressed its opinion that, as the question possessed a general bearing, it should be examined by a sub-committee, which should determine the form of table to be adopted by all countries. On the subject of the importance of actinometric observations, also brought forward by Dr. Hann, the Committee expressed the hope that the sub-committee for terrestrial and solar radiation would present a report upon that subject at the next International Congress. M. Violle submitted a note on the various methods employed for actinometric measurements. On the proposal of Dr. Pernter as to the desirability of the restriction of observations with the wet-bulb thermometer and the multiplication of observations with the hair hygrometer, the Committee came to no decision, pending the presentation of a full report upon the question. Dr. Paulsen, director of the Danish Meteorological Institute, drew attention to the importance for weather prediction of the laying of a cable between Iceland and Europe, towards which the Danish Government and the Great Northern Telegraph Company were prepared to make a considerable annual subvention. The Committee fully recognised the importance of the proposal, and expressed its hope of the ultimate success of the project. Profs. Neumayer and v. Bezold made a proposal relative to the publication of an international periodical weather report (recently referred to in our columns), which should contain ten-day means from about a hundred stations. The Committee was of opinion that it would be desirable that a definite plan of the proposed publication should be prepared for examination by each meteorological service. A sub-committee, composed of MM. Pernter (president), Billwiller, Neumayer, Rykatcheff, Mohn and Tacchini, was nominated for the purpose of considering the extension and improvement of international telegraphy for weather prediction. Finally, it was decided that the International Meteorological Committee and the various sub-committees should meet in Paris in the year 1900, immediately after the Meteorological Congress which will take place on the occasion of the Exhibition. This Congress will probably be held during the first half of September. We are indebted to M. Lancaster's summary in *Ciel et Terre* for the notice of this meeting.

THE COMING SHOWER OF LEONIDS.

DURING the past few years English observers, in their efforts to witness returns of the Leonid meteors, have met with little but disappointment. Either the firmament has been overcast at the important time, or the display has been very weak. The rarity and singular attractiveness of a really fine meteoritic exhibition are such that the immediate prospect of viewing an event of the kind has aroused great interest in the whole subject of shooting stars. But we have been a little premature in our anticipations in recent years, and looking for the appearance of the meteors before the vanguard of the denser portion of the stream had begun to cross the earth's path. There can, however, be no doubt as to the character of the ensuing display. The earth will be sure to encounter one of the richest regions of the orbit at the middle of November, but whether or not this collision will occur at an hour perfectly suitable for its observation remains to be seen. It must be admitted that the exact time of the *rencontre* cannot be definitely stated. The materials upon which computations have to be based are not sufficiently numerous and consistent to enable exact deductions to be drawn from them. Moreover, there is evidence to show that the system of meteors is constantly undergoing changes. The particles are spread out, and are still spreading out, over a very considerable section of the orbit, and are subject to perturbations by the larger planets. Different sections of the stream are affected unequally, so that the whole system, both as regards its conformation and distribution, suffers from such irregular disturbances, that we must be prepared for the visible signs of developments of an unexpected character. In the present state of our knowledge it is impossible for us to allow for all the various circumstances and conditions which control the visible aspect of the shower, from year to year, and modify its orbital elements.

Calculations which have been made independently by several authorities show that the influence of Jupiter and Saturn, since the last return of the shower in 1866, has been exerted in increasing the node, so that the phenomenon may be expected a day late in the present year It will probably occur just before sunrise on November 16. Drs. Stoney and Downing, in a paper published in the *Proceedings* of the Royal Society, vol. lxiv. p. 406, state that a noteworthy outcome of their investigations is that the meteor-group which gave rise to the display in 1866, made a near approach to Saturn in 1870, and to Jupiter in 1898. On the latter occasion the meteor-cloud was distant from Jupiter by an interval of space less than that separating the earth and the sun. Berberich (*Ast. Nach.*, 3526) has also discussed the orbit-perturbations of the Leonid stream, and concludes that the meteors will appear about a day later than they would have done under normal conditions. If there had been the average annual displacement of the node (equal 102″·6) the recurrence of the shower might have been anticipated on November 15 at about 1 a.m., but the perturbations seem to have increased the longitude of the node to the extent of 1¼°; so that the greatest intensity of the display must be awaited on the morning of November 16, in the twilight preceding sunrise.

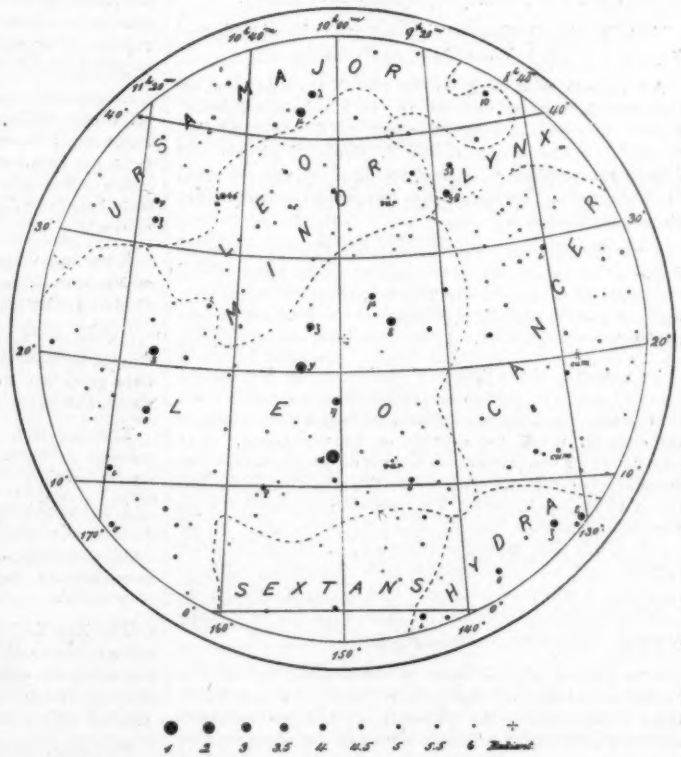
But it must be admitted that these deductions are liable to some uncertainty. Last year the predicted late-coming of the meteors was far from being corroborated by observation. The maximum number of meteors was recorded on the morning of November 15, and very few Leonids were presented on the following morning, though computation had indicated the latter as the time of maximum. In view of the prevailing doubts there seems no alternative but to watch for the shower throughout the morning of the 15th, and failing its brilliant apparition then, to repeat the watch on the morning of the 16th. The maximum may be displayed at any time between November 15, 0h. 30m. a.m. and November 16, 6h. 30m. a.m.

In England a November sky is cloudy on at least three nights out of four, and this year we shall have moonlight to consider as well, for our satellite will be nearly full, and must largely detract from the striking character of the display. Should the meteors appear on the morning of the 15th, they might, however, be seen on a dark sky, for the moon will set about 2½ hours before sunrise. The Leonids are fine meteors; a large proportion of them are as bright as 1st mag. stars, and, notwithstanding moonlight, will create a conspicuous effect if they return in great numbers. On the occasion of the last grand display on the morning of November 14, 1866, the writer was much struck with the number of tolerably bright meteors, and observed several which were many times brighter than Venus at her best. These Leonid fireballs gave lightning-like flashes, and left short green streaks, enduring for five, ten, fifteen minutes, and even more. The approaching display will be sure to supply a few of these splendid objects.

At every station where the weather enables the shower to be successfully witnessed, certain features ought to be particularly recorded. The meteors should be counted, and the time of maximum ascertained. It will be useful also to determine the hourly rate of apparition by noting at certain regular intervals the number which appear. By counting during short intervals and continuing the work for several hours, the rise and fall of the display as well as the number per minute at and near the time of maximum might possibly be obtained. In the event of an exceedingly abundant display, similar to that seen in America in 1833, the observer may feel bewildered and find it impossible to record the exact numbers. In such a case the figures should be estimated as carefully as possible.

Another feature will be to preserve a description of the time, brightness and apparent paths of any specially fine Leonids that may be visible. The paths should be marked on a celestial globe or suitable star-map, and the Right Ascension and Declination of their beginning and end points registered in a book properly ruled for the purpose. The length, duration and possible drifting of the luminous streak, left by every bright meteor, should also receive attention. Near the time of maximum, however, these details may be disregarded, as it will be necessary for the observer to concentrate his efforts to fixing the time of the maximum and strength of the display. A table with writing material and a lamp should be at hand so that numbers and notes can be hurriedly recorded by the observer almost without diverting his attention from the heavens. With more than one observer the various aspects of a meteoric shower can be fully recorded, but it is impossible to suppose that one person can watch its progress and record all the details presented.

Observers need not specially record the meteors with the main object of fixing the centre of radiation. We have already obtained a great number of eye-estimates of this position, and these must be put aside for the more accurate values obtainable by photography. No doubt the latter method will be extensively brought into requisition, though the bright moonlight will afford a serious hindrance on the present occasion. The Leonids begin to fall as early as November 7, and the shower is sustained over a fortnight. It will be very important to look for the meteors of this stream between about November 7–11, and record the paths of those visible with a view to definitely ascertaining the position of the radiant. At this early period of the shower's activity it is not probable that the photographic method will be appealed to. It is to be hoped that all regular meteoric observers will follow the progress of the shower with close attention during the second week of November in this year, for the questions as to the date of commencement of the shower and as to whether the radiant is a shifting or stationary one are very interesting features requiring settlement.



W. F. DENNING.

NOTES.

COLONEL J. W. OTTLEY, C.I.E., has been appointed president of the Royal Indian Engineering College, Coopers Hill, in the place of Colonel Pennycuick, C.S.I., resigned.

THE Committee of the British Association Table at the Naples Zoological Station announce that the Table is fully occupied until the middle of April next, but that applications for its occupancy from then until the end of August 1900, should be sent at once to the Hon. Secretary of the Committee, Prof. Howes, F.R.S., at the Royal College of Science, South Kensington. Mr. Kyle will occupy the table from now until Christmas, when he will be succeeded by Mr. M. D. Hill, who will continue investigations on the reproduction processes of Crustacea, and in March Prof. Herdman will go out and devote a month to the study of the Tunicata of the Bay.

THE Harveian Oration was delivered at the Royal College of Physicians by Dr. J. Vivian Poore on Wednesday last.

AN address will be given to the North-west London Chemical Society, on October 24, by Dr. Lauder Brunton, F.R.S., who will take as his subject "Biliousness and Gall Stones." On November 2, Sir J. Burdon-Sanderson will deliver an introductory address to the Middlesex Hospital Medical Society. To this all past and present students of the hospital are invited.

A TELEGRAM from Amsterdam, dated October 12, states that a violent earthquake has occurred in the south side of the Island of Ceram, in the Dutch East Indies, causing the death of some thousands of persons and the complete destruction of the town of Amhei. Details, however, are wanting.

AT a meeting of the Finance Committee of the Lincolnshire County Committee, held on the 13th inst., it was resolved that the County Committee be recommended to give their consent to the erection, within the grounds of Lincoln Castle, of an observatory for the preservation and use of certain astronomical instruments offered to the county by the executors of the late Canon Cross, of Appleby. The recommendation was made that the committee's consent should be given subject to the condition that the buildings shall not be commenced until sufficient funds have been raised for their erection and the future maintenance of the instruments. It is proposed to raise the funds by public subscription. We trust there will be a hearty response to the appeal that is to be issued.

AT a meeting of the Council of the London Mathematical Society it was resolved that the president (Lord Kelvin), the three vice-presidents, the treasurer, and the two secretaries should be nominated for the same offices at the annual meeting on November 9 next. Of the other members, Messrs. W. H. H. Hudson, D. B. Mair, and W. D. Niven, C.B., retire from office, and Messrs. W. Burnside, H. M. Macdonald and E. T. Whittaker were nominated to fill the vacancies. The Council also empowered the secretaries to publish an "Index" to the first thirty volumes of the *Proceedings*, on the lines of the similar index to the first fifty volumes of the *Mathematische Annalen*. Mr. Tucker was further authorised to draw up a complete list of members from the foundation of the Society in 1865.

THE Council of the Royal Photographic Society have decided to institute a series of monthly meetings, extending from November to April, to be especially devoted to illustrated lantern lectures. The meetings will be held on the first Tuesday in the month, and the first will take place on November 7.

THE second Traill-Taylor Memorial Lecture will be delivered on November 14 at the rooms of the Royal Photographic Society by Major-General Waterhouse, who will take as his subject "The Teachings of the Daguerreotype."

THE third International Congress of Photography is to be held in Paris from July 23 to July 28, 1900. Its purpose will be to re-examine decisions arrived at by the two last Congresses on problems before the Society, and to see if such are capable of further improvement or perfection. To inquire into the various new photographic questions arising since the last meeting. Practical demonstrations of working methods, lectures on special subjects, and visits to scientific and industrial institutions also form part of the programme. Those intending to be present are requested to address the General Secretary, M. S. Pector, 9 Rue Lincoln, Paris.

THE magnetic survey of Maryland has now been practically completed, the distribution of stations being such that on the average there is one station for every hundred square miles. The expenses of the work, with the exception of this year, have been entirely borne by the Maryland Geological Survey.

A SCIENTIFIC and commercial mission, under the direction of M. Ernest Milliau, Director of the Laboratory of Technical Experiments in connection with the Ministry of Agriculture, Paris, has been sent to Russia and Roumania with the object of taking measures for facilitating and extending business relations with those countries, especially with regard to the exportation of olive oils.

A BACTERIOLOGICAL institute has recently been established at Vladivostok, and a similar institute is shortly to be opened at Merv in Central Asia.

OWING to the prevalence of enteric fever in Natal, every man ordered for military service in that Colony has, says the *Lancet*, been given the option of being inoculated with anti-typhoid serum, and 70 per cent. of the troops have accepted the offer.

THE late Prof. O. C. Marsh's executors are about to sell his valuable collection of orchids, objects of art, antiquities, &c., for the benefit of the Yale University.

ACCORDING to the *Scientific American*, Japan is to send out an Arctic Expedition. The Japanese Government wishes, says our contemporary, to develop in the Japanese the spirit of adventure and discovery which has rendered the English nation so powerful.

THE New York Zoological Park, situated in Bronx Park, is to be opened to the public this month. The *Scientific American* states that the specimens which will be ready for public inspection will form but a small part of the exhibit, and that these will be very interesting.

THE return, after an absence of two years, of Mr. A. J. Stone, of New York, is announced. Mr. Stone has been travelling in the Arctic regions during the time mentioned, studying the geographical distribution of animals. It is reported that during five months of travel last winter he covered 3000 miles of coast and mountain entirely above the Arctic circle.

Science announces the return from Manila of the Johns Hopkins University Commission, which, under the direction of Dr. S. Flexner, has spent the past summer in studying tropical diseases.

THE death is announced, from Vienna, of Dr. Oscar Baumann, who had acquired some reputation as an African explorer. In 1885 Dr. Baumann joined the Austrian Congo expedition, subsequently visiting the island of Fernando Po, the Cameroons, and parts of East Africa. Other expeditions followed, in one of which he fell into the hands of hostile Arabs, and was only released on the payment of a ransom. He was entrusted with

the command of an expedition fitted out in 1889 by a German anti-slavery association. In the following year he explored the Usambara, and made preliminary observations for the purpose of tracing a projected railway in that region. In addition to a map of the Congo and numerous contributions to the reports of the Geographical Society of Vienna, Dr. Baumann published three books dealing with his travels and observations in Fernando Po and Usambara and with the rising in German East Africa.

WE regret to notice the death of Dr. J. W. Hicks, the Bishop of Bloemfontein, which has just taken place. The late Bishop was an earnest student of science, and was at one time a demonstrator in chemistry in the University of Cambridge, and published a text-book on inorganic chemistry. He was also a fully qualified medical man, having been made an M.D. in 1864, and an M.R.C.P. in 1865.

THE death has occurred, at Adirondacks, New York, of Mr. Hamilton Y. Castner, well known for his work in connection with the manufacture of aluminium and the establishment on a manufacturing scale of a process for the electrolytic production of alkali and bleaching powder from common salt.

THE *National Geographic Magazine* states that various sites within a radius of twenty-five miles of Washington are being examined by parties under Dr. Bauer's direction for the determination of the best location for the Coast and Geodetic Survey Observatory. The examinations thus far made have disclosed some interesting regional disturbances, especially in the vicinity of Gaithersburg. In order to determine what influence such regional disturbances have upon the variations of the earth's magnetism, such as, for example, the diurnal variation or the secular variation, it is proposed to mount a sensitive Eschenhagen dedinetograph at Gaithersburg, with the aid of which the variations of the most sensitive of the magnetic elements—the declination—will be continuously and automatically recorded.

THE British Fire Prevention Committee made a series of fire tests yesterday at their testing station as we went to press. The tests on this occasion were with a concrete floor, an iron safe, and two doors of wood. We are glad to see that the committee are continuing their valuable work in so energetic a manner. Valuable results may be expected to accrue from the experiments made by the committee from time to time.

A MONUMENT erected to the memory of Johannes Müller was unveiled at Coblentz on October 7. Prof. Virchow, who was the principal speaker at the cer emony, said in the course of his remarks that Müller was a biologist, a naturalist whose aim was the study of life itself in its universality. He was the first to use the microscope in researches on living beings, the first to disclose the fauna of the seas. His example inspired the deep-sea researches of to-day. Müller's method was observation; he put things into the right positions for exhibiting their action, and then registered his observations. At the time of Müller's youth it was believed that from inanimate nature, from atoms, from matter, or substance, new combinations might form themselves, which finally might lead to the generation of living organic forms, that, in short, plants and men might be evolved from dust. In modern times this had been named spontaneous generation. Johannes Müller warned against such hypothetic conclusions. He said: "We cannot generate living substance, and as long as we cannot do so, as long as we have no proof, we must put these theories aside"; and (said Prof. Virchow) that is the standpoint of resignation, of submission, that is the true position for a naturalist, such as Müller was. On the occasion of the unveiling of the monument, Müller's daughter presented to the State Library fourteen volumes of drawings, containing upwards of nine hundred zoological sketches made by her father in the years 1850–1854 in various countries.

THE Indian correspondent of the *Lancet* states that new regulations have been made with reference to persons sending or taking from place to place in India cultures or other articles known or believed to contain the living germs of plague. No person who is not a commissioned medical officer, a military assistant surgeon, or a medical practitioner in possession of a qualification not lower than that of L.M.S. of the University of Calcutta, Madras or Bombay shall without the special permission of the Governor-General in Council or a local government take in his private possession from one place to another any cultures or other articles which he knows or believes to contain the living germ of plague. No such culture shall be sent from one place to another unless it is securely packed in a hermetically closed tin of adequate strength, placed in a strong outer box of wood or tin, with a layer of at least three-quarters of an inch of raw cotton wool between the inner and outer case, the outer case being enclosed in a stout cloth, securely fastened and sealed, and labelled with such distinguishing inscription as will suffice to make immediately manifest the nature of the contents.

ACCORDING to a recently issued consular report, a new process for the production of ammonia has recently been discovered in Germany. The process is said to be at present an expensive one, but this difficulty will, it is thought, be overcome.

AN American paper, the *Pharmaceutical Era*, has published an article by Mr. H. M. Whelpley, of St. Louis, in which particulars are given as to the use of the metric system in American physicians' prescriptions. It appears from the article that out of 1,008,500 prescriptions examined, only 6 per cent. were in the metric system. The information was obtained from apothecaries in forty-two States and territories.

A SHORT article in the current number of the *National Geographic Magazine* sums up in brief the main results of Lieut. Peary's explorations in 1898–99, from which we extract the following information:—In the south Peary discovered that the so-called Hayes Sound, north-west of Cape Sabine, is only an inlet or bay. It was supposed by many that it extended through to the Arctic Ocean west of Ellesmere Land, and separated that country from Grinnell Land on the north. It is now proved that these regions are one and the same land. He also travelled west across the northern part of Ellesmere Land, which has never before been penetrated for any distance, and visited its west coast, joining his survey of the shoreline with the short bit of the coast further north, which Lockwood, of the Greely Expedition, discovered in May 1883. This is the first time that any part of this coast has been seen south of the inlet visited by Lockwood. In his various sledge journeys up the channel from the *Windward's* position, Peary skirted the east coasts of Grinnell Land and Grant Land for a distance of about 250 miles, rectifying the mapping of this shore-line in some respects, and particularly the surveys of a number of indentations. The most northern point reached by Peary was Cape Beechey, about 82° N. latitude. No effort to push northward has been made this summer, and Peary's winter camp has been established on the Greenland side of Smith Sound, several miles further south than his quarters of a year ago.

PROF. KOCH has published his first report on his study of malaria in Italy in the *Deutsche Medizinische Wochenschrift*. In all the cases of malaria examined by Prof. Koch and his assistants the parasite of malaria was found in the blood. Apart from the blood of human beings, the parasites occurred only in some species of mosquitoes which were met with only in the summer. The mosquitoes convey the malaria germs

from one human being to another; the infection is especially maintained and propagated by the relapsing cases which continue all the year round and form the link between one fever season and the next, so that the mosquitoes in the beginning of summer always find germs. If no relapse occurred in any of the cases of malaria in any given district the mosquitoes would find no germs in the beginning of summer, and malaria would become extinct there. Prof. Koch succeeded in recognising certain species of mosquitoes in the dwellings of the population; this was the more important, as the mosquitoes of this district did not usually bite during the day but only during the night. The inhabitants therefore became infected at night within their dwellings. In seven cases parasites of malaria were discovered in insects, especially in *Anopheles maculipennis*. In many dwellings, however, where patients had contracted malaria, anopheles was not present, but another insect, *Culex pipiens*, was hardly ever absent. Prof. Koch ascertained that the so-called æstivo-autumnal fevers were identical with tropical malaria.

Industries and Iron gives particulars of an electric fog-alarm which, it is reported, has been invented by a Canadian electrical engineer. The description is as follows:—A naphtha engine supplies the motive power to a dynamo that furnishes the electric current, by means of which three pairs of electromagnets operate half a dozen clappers that strike against a large gong with a frequency of about 36,000 strokes a minute, producing an almost continuous sound. Its effectiveness is enhanced by a mechanism somewhat on the principle of a megaphone, by means of which the sound is not only intensified but thrown in the required direction. A model of this fog-alarm was not long ago tested at Ottawa, and although it was comparatively a small affair, its sound was easily heard a distance of two miles. The sound of the completed machine will be (it is thought) distinguishable at a distance of fifteen miles.

As an example of the interest that is taken in anthropology on the continent, we call attention to the publication of the free courses of lectures delivered by Prof. E. Morselli at Turin and Genoa. The title of the publication is "Antropologia Generale: Lezioni su l'Uomo secondo la Teoria dell' Evoluzione." When will it be possible for the English public to hear systematic lectures on anthropology of any kind, free or otherwise? Prof. Morselli puts his subject clearly, judging from the portions only of the two lectures that we have received.

ANTHROPOLOGISTS who more particularly study European ethnology should be very grateful to Dr. William Z. Ripley, of Boston, for the "Selected Bibliography of the Anthropology and Ethnology of Europe" that has just been issued by the Trustees of the Public Library of Boston, Mass. The list contains nearly two thousand titles in nearly all the languages of Europe; the Slavic writers are very well represented. The authors are arranged in alphabetical order, and their several publications are cited chronologically; this is followed by a subject-index. The labour of compiling this bibliography must have been immense, but Dr. Ripley will have the satisfaction of feeling that he has supplied his colleagues with a valuable and indispensable tool.

AMONG the most useful instruments employed in Italy for the registration of earthquake movements are the microseismographs, designed by Prof. Vicentini and modified by Dr. Pacher, which have been erected in the Physical Institute of the University of Padua. Hitherto the records have been published at irregular intervals in the *Atti* of the R. Istituto Veneto di Scienze, &c., but it is now arranged that they shall appear systematically and ultimately form an appendix to the yearly volume. The first number, recently issued, contains the register from January 1 to March 12 of the present year, and also notes with regard to the arrangement of the different instruments.

THE tin trade of prehistoric Europe is a subject of considerable interest and importance. Very recently Salomon Reinach (*l'Anthropologie*, x., 1899, p. 397) has again attacked the problem and has arrived at the following conclusions. A thousand years B.C. there was an almost exclusively overland trade between the British Islands and Thrace and Macedonia. The relations between Britain, Northern Europe and Western Asia have been proved by archæology, by the diffusion of tin, amber, spiral ornaments and the types of bronze arms and utensils. Thus it is not surprising that Homeric Greece about 800 B.C. knew not only the Celtic name of the Cassiterides, but the phenomenon of the short nights of the north of Britain. The overland tin was brought to the Ægean, if not by Greeks, then by Barbarians. These Barbarians, accurately knowing the country from which the tin came, sought a marine route in order to retain this precious trade in their own hands. This was rendered more feasible by the invention of the anchor by the legendary Midas of Phrygia, for then ships could ride with safety in the open. Reinach considers that it was he who first brought tin and lead to Greece by sea by the north-west route, and it was only later that the Phœnicians got the tin trade into their hands. The English Leake, Hamilton and Ramsay have rediscovered Phrygia, but twenty-seven centuries ago the Phrygians discovered England.

THE *Bulletin de la Société Astronomique de France* for October contains several interesting meteorological articles. M. E. Touchet contributes an illustrated article on the storms of August and September 1899, showing some excellent lightning pictures. He gives special attention to the type of lightning which is apparently unaccompanied by thunder. M. A. Souleyre, writing on the "distribution of rain on the earth," summarises the interaction of the various air-currents and the barometric variations connected with rainfall. MM. V. Farquon and F. A. Mavrogordato give short accounts of their observations of the "green ray" on the Alps and at Smyrna respectively.

THE October number of the *Journal of Conchology* contains an interesting paper by Messrs. Melvill and Standen on the cowries of the *caput-serpentis* group. In that group are included not only species with a dark peripheral area and a spotted centre, like the typical *Cypraea caput-serpentis*, *C. mauritiana*, and *C. arabica*, but likewise the ring cowry (*C. annulus*) and the familiar money cowry (*C. moneta*). The two latter, as many of our readers are aware, are white; the yellow ring from which the second of the two derives its name marking the line of division between the spotted central and the dark peripheral area of the serpent-head cowry (*C. caput-serpentis*). If proof were necessary to demonstrate that this is the true explanation of the coloration of the two species, it is afforded by the discovery of a white example of a variety of *caput-serpentis*, in which the dorsal spots are still faintly visible. It has been recently stated by another writer that "from the ring cowry may easily be derived the money cowry, in which the ring has all but disappeared, while the marginal area has developed a series of rugosities, apparently connected with the filaments on the margins of the mantle lobes." And Messrs. Melville and Standen now come to the conclusion that these two cowries are really nothing more than races of a single species, for which the name *C. moneta* should be retained.

THE last number of the *Transactions* of the Norfolk and Norwich Naturalists' Society bears ample testimony to the maintenance of the taste for natural history and botany which has always been so characteristic of that favoured county. As is only proper, the great bulk of the papers refer to local

subjects, while a few, like Mr. Warde Fowler's notes on the birds of the Somme Valley, supplement the history of native species in other lands, the remainder having no particular connection with the county. Especial interest attaches to Mr. S. F. Harmer's note on the occurrence of the well-shrimp (*Niphargus*) near Norwich; and likewise to Mr. J. H. Gurney's account of the distribution of the Bearded Tit. Various specialists bring the lists of the Norfolk fauna and flora up to date. And those who study economic zoology will be interested in the notes of Mr. G. H. Harris on the herring fishery of 1898. So far as the Yarmouth boats were concerned, this appears to have been a practical failure. It was not that the catch was always bad; but, whatever the catch, prices were forced down by the poor quality of the fish. And this is mainly attributed to the mild season, herrings being never of high quality in warm weather.

AMONG recent papers in the *Journal of Applied Microscopy*, Mr. Charles J. Chamberlain's series of articles on "Methods in Plant Histology" will be useful to teachers and students of practical botany. The last articles contain illustrated accounts of the principal families of algæ with methods of preparing for observation. One of these methods is, however, capable of improvement. To place specimens in a 10 per cent. solution of glycerine, and allow the solution to evaporate till it is of the consistency of pure glycerine would be unnecessarily tedious. It is simpler and equally efficacious to place the specimens in water in a small receptacle of parchment paper, and float the latter on glycerine, the change of density taking place through the paper by osmosis instead of by evaporation.

A VERY clear photographic group of official members of the recent Dover meeting of the British Association, together with members of the French Association and the Belgian Geological Society, has been sent to us by the photographers, Messrs. Lambert Weston and Sons, of Dover, from whom copies may be obtained. In the majority of instances the individuals portrayed can easily be identified.

THE additions to the Zoological Society's Gardens during the past week include a Rhesus Monkey (*Macacus rhesus*, ♀) from India, presented by Mrs. J. Adams; a Black-faced Spider Monkey (*Ateles ater*) from Eastern Peru, presented by Mr. Claude P. Landi; a Common Chameleon (*Chamaeleon vulgaris*) from North Africa, presented by Mr. A. H. Ryan; a Red-cheeked Souslik (*Spermophilus erythrogenys*), four Eversmann's Sousliks (*Spermophilus altaicus*), four Altai Sousliks (*Spermophilus mugosaricus*) from Western Siberia, a Common Seal (*Phoca vitulina*), British, a Common Cormorant (*Phalacrocorax carbo*, var.), European, an Emu (*Dromaeus novae-hollandiae*), three Long-necked Chelodines (*Chelodina longicollis*) from Australia, an Uvæan Parrakeet (*Nymphicus uvaeensis*) from the Island of Uvea, a Rosy Parrakeet (*Palaeornis rosa*) from Burmah, a Four-lined Tree-frog (*Polypedates quadrilineatus*) from the East Indies, a Westerman's Eclectus (*Eclectus westermani*) from Moluccas, deposited; six Glossy Ibises (*Plegadis falcinellus*), bred in the Gardens.

OUR ASTRONOMICAL COLUMN.

COMET GIACOBINI (1899 *c*).

Ephemeris for 12*h. Berlin Mean Time.*

1899.	R.A. h. m. s.	Decl. ° ′	Br.
Oct. 19 ...	16 57 8 ...	+0 46·4	
21 ...	17 0 3 ...	1 19·0	... 0·71
23 ...	2 59 ...	1 51·2	
25 ...	5 55 ...	2 23·0	... 0·66
27 ...	8 52 ...	2 54·5	
29 ...	17 11 49 ...	+3 25·6	... 0·62

A circular from the Centralstelle at Kiel informs us that owing to an error in one of the published observations, there is some doubt as to the correct elements of this comet. In consequence of this the above ephemeris may not be quite accurate, but, as according to the latest observation recorded, it is less than one minute in R.A. and two minutes in Decl. in error, it will be useful for searching purposes. The comet is travelling to the north-east through Ophiuchus, a little south of the second mag. star α Ophiuchi.

HOLMES' COMET (1899 *d*).

Ephemeris for 12*h. Greenwich Mean Time.*

1899.	R.A. h. m. s.	Decl. ° ′ ″
Oct. 19 ...	2 53 1 ...	+48 49 51
20 ...	51 57 ...	48 54 5
21 ...	50 51 ...	48 57 56
22 ...	49 44 ...	49 1 25
23 ...	48 36 ...	49 4 30
24 ...	47 27 ...	49 7 13
25 ...	46 17 ...	49 9 33
26 ...	2 45 7 ...	+49 11 29

This comet is now in the middle of Perseus, being nearly on the line joining β and γ Persei, about two-thirds of their distance from the former.

OPPOSITION OF JUPITER, 1899.—*Astronomische Nachrichten* (Bd. 150, No. 3596) contains the results of several observers' work on the planet during the last opposition of 1899 April 25. M. J. Comas Solá, of the Catala Observatory, gives a planispheric map of the markings observed by him with a Mailhat objective of 22 cm. aperture, from February 18 to July 8. Tables are given showing the various rotation periods obtained from observations of spots in different zones, a summary of which is as follows:—

Mean velocity of spots on south border of equatorial zone ... } = 9h. 50m. 23·35s. (from 22 spots)

Mean velocity of spots on north border of equatorial zone ... } = 9h. 50m. 15·25s. (from 9 spots)

∴ mean equatorial velocity ... = 9h. 50m. 20·76s.

This, compared with Denning's mean velocity for 1898, 9h. 50m. 23·6s., would indicate an acceleration since the spring of 1897.

Measures of the "red spot" gave a period of 9h. 55m. 41·85s.

Herr Ph. Fauth also gives a planispheric drawing showing the details observed from May 30 to June 13, with a Pauly objective of 17·8 cm. aperture.

Mr. A. Stanley Williams, of Brighton, gives his observations of the "red spot" made during the period March 13 to June 16 with a 6½-inch reflector. The period found is given as 9h. 55m. 42·65s. from 229 rotations (March 13 to June 16). He finds the spot to be a little shorter now than it was in 1887 (31°·7 instead of 34°·7).

LAW CONNECTING MOTIONS IN PLANETARY SYSTEM.—M. Ch. V. Zenger, of Prague, has recently put forward the results of work he has been engaged on for some years past, and a part dealing with the relations existing between the "time of a planet's revolution" and its position in the solar system appears in the *Bulletin de la Soc. Ast. de France*, October 1899, pp. 431–434. He finds that the orbital movements of the planets and also of some periodical comets have a simple law connecting them with the time of the sun's rotation. If "*r*" is the time of *rotation* of the central controlling body, then "R," the time of *orbital revolution* of the planet, is given by the relation $R = n\frac{r}{2}$; where "*n*" is a whole integer, different for each body.

Taking Faye's value for the solar rotation = 25·2 days, $\frac{r}{2}$ = 12·6 days, and the author gives the following data:—

	Mercury	Venus	Earth	Eros	Mars	Jupiter	Saturn	Uranus	Neptune
N=	7	18	29	51	84	344	854	2436	4776
R=	88·2d.	226·8d.	365·4	642·6	680·4	4344·4	10765·4	30693·6	60177·6.

Between the earth and Eros, the author mentions the possible existence of a hitherto unknown planet for which *n* = 40, and the period of revolution of which would therefore be about 500·4 days.

Several tables are also given showing the conformation of the satellites of the various planets to a similar relation, and the author considers the whole as helping to confirm his electrical theory of the solar system.

ON THE CHARACTERISTICS OF A UNIVERSITY.

THE beginning of a new academical year is one of those periods of sudden change which must leave its mark for good or bad on every university and college in the land. Well-known faces of those who have been prominent in work or sport are missing. New recruits are taking, with halting steps, their first lessons in the drill which is soon to become so familiar. In a few days they will be undergoing their "baptism of fire" in struggles wider and keener than any in which they have yet been engaged; and in which each, according as he bears himself, must either add to or diminish, be it by ever so little, the position which his college holds in the eyes of the world. At such a period we naturally halt for a moment, and before we face the future, cast our eyes backward.

One conspicuous change has taken place in the past session. Sir John Donnelly has retired from the permanent headship of the Department of Science and Art, and has been replaced under new conditions by Captain Abney. It would be contrary to all the wholesome traditions which govern the conduct of servants of the Crown if I attempted to discuss these important events. I will therefore only say, in words which are colder than my feelings, that we wish our late chief long life, health and happiness in the rest to which the strenuous service of many years has entitled him; and that we welcome as his successor one who is not only a distinguished public servant, but a distinguished man of science.

Two losses, I must mention, of men who, though unknown to each other, were both known to many of us. Both had, in different ways, deserved well of the college. Both have passed away since the last term ended. But though alike in these respects, their fates were strangely different.

Sir Edward Frankland, for long Professor of Chemistry in this college, had touched the topmost rungs of the ladder of scientific fame. The Royal Society bestowed upon him its highest honour—the Copley Medal. The French Academy of Sciences had given him the highest distinction it can confer upon one who is not a Frenchman, by placing his name on the select list of eight foreign members. Happy in the work of his life, he was no less happy in the opportunity of death. The end came, without long previous suffering or slackening of mental power, in the midst of the holiday haunts which must, as life faded, have recalled some of its brightest hours. The Royal College of Science will remember him as one of the earliest and the most distinguished members of its staff.

The other name I would mention is that of one who was recently numbered among our students. Ernest Harrison gained the Associateship in Physics a year ago, taking the first place in the final examination. He had previously won a scholarship at Trinity College, Cambridge. His career here gave reason to believe that his future would be successful; but his early death has quenched the hopes of his teachers and his friends. The fact that he has died a very young and therefore a comparatively unknown man, makes it all the more the sad duty of us who knew him to record the promise of his youth.

Turning from the past, the changes which loom largest in the immediate future are the erection of the new buildings and the creation of what will in effect be a new university. Of the former I will only say that they will be on a scale not unworthy of the largest city in the world; but the establishment of a teaching university must be so pregnant with good or ill that I shall offer no apology for returning, by a somewhat different line of approach, to a subject on which Sir Norman Lockyer dwelt last year.

Let us then, in the first place, ask what are the chief notes which distinguish from all others the mode of preparation for the work of life which should be characteristic of a university.

Put shortly, I take it that two notes are predominant above all the rest. The first is that a university is a place where education is combined with the advancement of knowledge; the second, that the teaching of a university is based upon the principle that knowledge is desirable for the influence which knowledge and the search for knowledge exert upon ourselves, and not merely for the power which they confer of improving our external surroundings. The first of these characteristics distinguishes the university from a school; the second from a workshop or a college with purely technical aims.

[1] Address delivered at the opening of the Royal College of Science, October 5, by Prof. Rücker, F.R.S.

I shall say very little on the fact, which no one will dispute, that it is the duty of a university to advance knowledge. To do us justice, we of the Royal College of Science have not been unmindful of this duty. It is impossible to speak of the present or more recent past, but I may be permitted to say that a college which has numbered Huxley, Stokes and Frankland among the members of its staff will have forgotten all the teaching of its earlier history if it ever fails to satisfy the first test of fitness for a university status. I only hope that the schemes which are being mooted for founding new research professorships do not veil an attempt to place in other hands that part of the work of the London colleges which is specially characteristic of a university. London needs a multiplication of teachers on a sufficiently large scale to enable them to conduct both teaching and research, not the creation of separate castes of teachers and investigators.

Let me turn next to the second note of a university, viz. that it insists that knowledge has a value apart from the commercial or utilitarian objects for which it may be used.

In this capacity a university maintains, or ought to maintain, a constant protest against the view that a man and his knowledge are to be measured by their money value alone. This view was never more clearly expressed than by Colonel Diver, according to whom the aristocracy of New York consisted "of intelligence, sir, . . . of intelligence and virtue. And of their necessary consequence in this republic—dollars, sir." It is needless to deny that "dollars" are often the reward of intelligence and virtue. In the case of most men, the search after them must necessarily be a matter of importance; but this fact is too often used to make preparation for the business side of life the only or the chief end of education.

As I was writing these lines a number of *Literature* reached me, in which there is a review of a work by an assistant professor of the history and art of teaching in the Harvard University. This gentleman proposes to have "commercial courses" in all the schools. The purpose of these courses is to be, not merely "to train a youth to an appreciation of the functions of business and business practice in our modern life," and not merely to "inform him as to the history of industry and trade," but also to "awaken in him a profound interest in business as such," and to "train him to keep his eyes open to business possibilities."

Before I have done you will understand my reasons for agreeing with the reviewer that this is a "hideous educational programme." For the moment I will content myself with saying that it is based upon a one-sided view of life. There can be no question but that the business element is important, but a university is a corrective to the tendency to regard money as the only standard of value. This it does by inviting us to study and to care for things which we must admit are important and beautiful, but which we may not be able to convert into coin.

But, you may ask, if this is so, will not the admission of technical colleges such as is, in part, our own, be inconsistent with your idea of a university?

To this I answer that, while it is possible that the desire to master the practical applications of knowledge might crush the desire to know things which are worthy to be known though not of immediate commercial advantage, the men who are managing the best technical colleges are aiming at leavening the technicalities of a profession with the love of knowledge. Example will illustrate what I mean better than precept. The late Dr. Hopkinson was a successful engineer, sought after to superintend great undertakings. Busy in the office and the law courts, he nevertheless was always investigating the secrets of nature, and wrote his name large in the *Transactions* of the Royal Society. Many others, whom in this room I need not mention, are animated by the same spirit. I think, therefore, that the welcome which several of our universities have extended and are extending to such men and to their students is a legitimate recognition of the fact that they have effected a real extension of the boundaries of the region in which the love of knowledge for its own sake prevails. It would be a disaster if the spirit of business and commerce were to dominate a university. It will be a triumph if the love of science and the love of culture were spread from the technical college to the machine shop and the factory.

And this brings me to my next point, to another and more subtle question, in some respects similar to that we have been discussing.

In life there is a competition, not merely between commercial

and intellectual interests, but between different intellectual interests themselves; and a characteristic of a university education is that by some means or other it aims at conveying, not merely accurate knowledge on some one subject, but a healthy interest in all forms of mental effort. This wider range, this general cultivation, should distinguish the university scholar from him who has merely mastered the technicalities of a profession. A man may be a good lawyer or tradesman, he may have grasped a branch of pure science or succeeded in a scientific profession, and yet be careless and ignorant of all that does not bear upon the central interest of his life. The blending of expert and general knowledge, of professional skill in some one subject and of intelligent interest in others, is not to be accomplished by obeying formal rules, such as those which must be followed in producing a given chemical compound. Each one of us must decide for himself what particular combination represents for him the maximum of gain and the minimum of loss; but the true university as distinguished from the professional or technical school is for ever preaching that man is many-sided, that the light of heaven reaches him through many windows, and though to some of us the call may come to sacrifice all else to gain one supreme end, yet it is well to count the cost and to remember that the loss may outweigh the gain.

In speaking of sacrifice I am not now referring to the ordinary habits of industry and self-control which are essential to success in any physical or intellectual struggle. I am dealing rather with that sacrifice which is so often made without any sense of loss, the surrender of all effort to understand the appeal made by nature or art to one or other of our higher intellectual powers.

A man may be so interested in painting or in music that he loses all sense of the divine curiosity which impels the man of science as he strives to unravel the plan of the universe. The seeker after truth may allow the dry light of science to wither the sensibilities which can be touched by art alone. He may purchase the higher knowledge at the cost of the higher emotions.

Let us then consider for a few moments the principles which should direct our choice, and the help which a University of London can give us in choosing.

With regard to principles, it is impossible, as I have already said, to lay down any hard and fast rules. In this, as in so many other questions on which a practical decision must be made, two extreme courses are possible to follow, either of which is in most cases clearly wrong. I shall call before you a distinguished advocate of each, and allow them to plead in their own words.

The first policy may be called the policy of concentration, dear to the apostles of the gospel of self-help.

"The one prudence in life," says Emerson in his essay on Power, "the one prudence in life is concentration; the one evil is dissipation: and it makes no difference whether our dissipations are coarse or fine; property and its cares, friends, and a social habit, or politics, or music, or feasting. Everything is good which takes away one plaything and delusion more, and drives us home to add one stroke of faithful work. Friends, books, pictures, lower duties, talents, flatteries, hopes—all are distractions, which cause oscillations in our giddy balloon, and make a good poise and a straight course impossible. You must elect your work; you shall take what your brain can, and drop all the rest. Only so can that amount of vital force accumulate which can make the step from knowing to doing. . . 'Tis a step out of a chalk circle of imbecility into fruitfulness."

And yet what counsel is this! To you the happiness or sorrows of your friends are to be mere distractions which make a straight course towards the conclusion of your own task impossible. Politics—that is the well-being of your country; books, the whole world of literature; music and pictures, all these are mere playthings and delusions, which you are to cast aside with all other childish things, and now that you are a man you are to care only for doing your own stroke of faithful work.

It is nothing to you that you are viewing with callous indifference the faithful work of others. "At sundry times and in divers manners" the noblest of our race have been striving to express the best that was in them by poetry and prose, by line and colour, by oratory and music. You are to care for none of these things. They are dissipations—not indeed of the coarsest kind—but dissipations none the less, dissipations which distract you from your own sustained and self-conscious endeavour to do something which may perhaps entitle you to rank among the meanest of those whose works you spurn. And then, when the work is done, the discovery made, the memoir published, what wonder if they in turn regard it with a disdain not less than your own? what wonder if Charles Lamb, along with Court Calendars, Directories, Draught Boards, bound and lettered on the back, and Almanacs, should place scientific treatises in his list of Biblia A-Biblia; or Books which are not Books?

Turn now to the other extreme policy, that which regards it as our wisdom to aim, not so much at one high end which can be attained only by an intense concentration, as at the "fruit of a quickened, multiplied consciousness."

No one has put the case in support of this philosophy more eloquently than Walter Pater in the celebrated conclusion to his "Studies in the History of the Renaissance."

The passage is too long to quote in full, but he tells us that the service of culture to the human spirit "is to startle it into a sharp and eager observation.

"Every moment some form grows perfect in hand or face; some tone on the hills or sea is choicer than the rest; some mood of passion or insight or intellectual excitement is irresistibly real or attractive for us—for that moment only.

"Not the fruit of experience, but experience itself is the end. A counted number of pulses only is given to us of a variegated, dramatic life. How may we see in them all that is to be seen by the finest senses? How can we pass most swiftly from point to point, and be present always at the focus where the greatest number of vital forces unite in their purest energy?

"To burn always with this hard gem-like flame, to maintain this ecstasy, is success in life. Failure is to form habits; for habit is relative to a stereotyped world; meantime it is only the roughness of the eye that makes any two persons, things, situations, seem alike.

"While all melts under our feet, we may well catch at any exquisite passion, or any contribution to knowledge, that seems by a lifted horizon to set the spirit free for a moment, or any stirring of the senses, strange dyes, strange flowers, and curious odours, or work of the artist's hands, or the face of one's friend.

"Not to discriminate every moment some passionate attitude in those about us, and in the brilliance of their gifts some tragic dividing of forces on their ways, is, on this short day of frost and sun, to sleep before evening."

Beautiful words! But as their music fades from the ear, as the brilliance of the "hard, gem-like flame" is quenched by the light of day, can we accept their teaching? Not to do but to feel, not to achieve but to enjoy, is the rule of life to be deduced logically from these premisses. If some great work is to be attempted, it is for the sake of the experience, for the joy of the effort and the success, and not for the sake of the work itself. Even "the enthusiasm of humanity" is classed by Pater among the "high passions," which are valuable chiefly for "the quickened sense of life" they impart; and beyond and above them all is placed art, not because it leads to a noble end, but because it professes "to give nothing but the highest quality to your moments as they pass, and simply for those moments' sake."

If the doctrine of concentration leads to ignorance of the work of others, the doctrine of the multiplication of states of consciousness leads to the neglect of what you yourself may do. Nay, more; it leads to the paradoxical result that you laud and magnify the achievements of those whom, nevertheless, you count as having failed in life, if their work, like most of the best work of the world, has been brought to the birth with bitter travail; and if, in the effort to achieve, they have sacrificed the joys to be found in "strange dyes, strange flowers, and curious odours."

If you have to choose one philosophy or the other, to adopt one rigid rule of life, I take it that the nobler among you would follow Emerson rather than Pater, would prefer to do "one stroke of faithful work" rather than to maintain a life long ecstasy. But this is not one of the cases in which no compromise is possible, in which we must vote "Yea" or "Nay," and must put aside wholly one teaching or the other. It may be a great thing to make the efforts and sacrifices which are required in adopting an extreme position, but it is a still higher achievement to maintain through life the intellectual balance necessary for the policy of the "golden mean."

I am not concerned to deny that radically different views

underlay the teaching of Emerson and Pater, but nothing is more certain than that neither Emerson nor Pater meant the passages I have read to be taken in the literal sense which might be ascribed to them. Even in the teaching of science it is sometimes necessary for the teacher to aim at being clear rather than correct; to force home the appreciation of the nature of some central truth by stating it as boldly as possible, and by sacrificing the pedantic exactitude which would insist that in its very first presentment it must be hedged about with every qualification and safeguard which long experience could suggest.

This was not the policy of the American teacher. Having set the mind in motion he left to its natural "after working" the discovery of qualifications and safeguards.

"Emerson," says Mr. John Morley, "has not worked out his answers to these eternal enigmas, for ever reproducing themselves in all ages, in such a form as to defy the logician's challenge. He never shrinks from inconsistent propositions. He was unsystematic on principle. 'He thought that truth has so many facets that the best we can do is to notice each in turn, without troubling ourselves whether they agree.'"

No better evidence of the truth of this remark could be adduced than Emerson's treatment of the relative importance of special knowledge and general culture. We have heard him on the one side. Let us listen to what he has to say on the other.

"He only is a well-made man who has a good determination. And the end of culture is not to destroy this. God forbid! but to train away all impediment and mixture, and leave nothing but pure power. Our student must have a style and determination, and be a master in his own specialty. But, having this, he must put it behind him. He must have a catholicity, a power to see with a free and disengaged look every object."

Nor by putting "behind him" did Emerson mean that the student was to devote all his earlier years to one form of intellectual effort: and that when this had brought him competence or fame, he might turn for relaxation to what he had hitherto neglected—to art or science or literature, as the case might be.

"Culture," he says elsewhere, "cannot begin too early. In talking with scholars I observe that they lost on ruder companions those years of boyhood which alone could give imaginative literature a religious and infinite quality in their esteem."

He who has pored too closely and too long over one study cannot in a moment cast aside the fetters which the years have woven round him, and rise up, like Samson, a terror to the Philistines. The intellectual sectarian cannot by a sudden act of will or process of conversion become the intellectual catholic. As well might he hope that the muscles which have been disused for years should suddenly rival the sturdy frame of the athlete, that the bent back should become straight, and the vision of the wearied eyes keen. Mental, like physical powers, are atrophied by disuse. The arts of seeing something of many things and all of one must be cultivated at the same time, or side by side.

And Pater, like Emerson, trusted to the intelligence of the reader not to mistake the strong presentment of one side of a question for a judicial decision on the whole case. So shocked was he when it was pointed out to him that his teaching might be taken too literally, that he actually suppressed the magnificent passages I have read to you lest his meaning should be misunderstood.

For each of us, then, the safest path lies somewhere between these limits, though thousands lead dull or unsuccessful lives because they shape their course perilously near to one or other of them. My object to-day is to warn you against the two extremes, not to attempt to lay down rules which shall point out the best course between them, rules which could not serve for all characters and dispositions alike. Do not forget that nothing considerable is achieved without concentration. Remember that he who holds himself free to cast aside every interest which does not directly bear on the central object of his life purchases this freedom "with a great price."

Let us next inquire what a university can do to guide the student in his choice. And here I may say at once that in my opinion the methods which have been officially adopted have been open to grave criticism; and that even if this were not so, the secondary are at least as important as the primary effects of a university training.

The direct official method of promoting general knowledge has been to insist that the candidate must pass an examination in several diverse subjects either before or during his passage through the university.

No objection can be raised to regulations which insist that a student before entering the university shall have acquired the elementary knowledge and have undergone the intellectual training which may enable him to undertake more difficult studies; but cultivation is not attained by mastering Latin and Greek up to the point at which they become useful engines for cultivation, and then throwing them aside for life. To change the metaphor, studies so treated are, in the words of Mr. John Morley, "superfluous roots in the mind, which are only planted that they may be presently cast out again with infinite distraction and waste."

Mistakes such as these are due to the fact that, though each subject of study when regarded as central is surrounded by others which are very different from itself, but which nevertheless prop and support it, these subsidiary subjects are (as a rule) not officially recognised in the examinations for a degree.

Every scientific man would agree that a student who can read French and German is better prepared for a scientific career than one who, with an equal knowledge of science, can read English only. Why not allow to the higher attainments greater weight? Again, there can be no doubt that a scientific essay or treatise written in good English tends more to the advancement of "natural knowledge" than if the facts and arguments are badly expressed. Why not recognise this fact, as the Department of Science and Art has now done, by giving credit in the Honour examinations for the style in which the essays of candidates are written?

By such steps we should, at all events, secure that the teacher of science who chooses to take some pains with the essays of his students, or who urges them to learn to read French and German easily, should not feel that his advice, however useful it might ultimately be, would damage rather than improve their chances of a high place in the examination for a degree in science. Thus, too, we should keep open in the student's mind avenues by which he might attain to some interest in language and literature for their own sakes.

I am well aware of the objections which might be raised to such a scheme; and though I do not myself attach great weight to them, I will now only insist that if they are valid that fact is an additional proof of the truth of a proposition, which I do not deny, viz. that it is not so much by directing the studies of each individual student, as by bringing together teachers and learners who are teaching and learning very different things, that, by a mental "law of exchanges," the interests of all are widened.

It is no doubt a weak point in a college such as ours that the range of instruction is limited to science and to some of its applications, and that thus you are all studying closely allied subjects. Union with other colleges in a university may help to remedy this defect. Meanwhile, all that can be done officially to promote general cultivation is small compared with what you can do for yourselves and for each other, and this because you are at liberty to embrace a wider range than any university would be justified in forcing upon you. Your success as specialists will largely depend upon your studies and your teachers. Your wider cultivation will chiefly be the work of your relaxations and your friends.

Do not misunderstand me. In general, a young man with no physical defect will and ought to take an interest and a part in athletics. In a great metropolis this is even more necessary than in the case of universities which, like Oxford, Cambridge, St. Andrews or Göttingen, are comparatively in the country.

I am proud to be the president of a Boat Club which this summer won a race in a Thames regatta. I have been treasurer of two scientific societies, and am glad to be now the treasurer of the United Football Clubs of the engineering departments of the London Colleges. I hope and believe that these are the germs from which the athletic clubs of the future university will spring. I hope and believe that the undergraduates of that university will not differ from all other groups of young Englishmen in that, while engaged in the cultivation of intellect and taste, they neglect the cultivation of thews and sinews. But if it be granted that college work and college sports must fill up much of the time of all of you, there are still spare but precious moments in which you cannot indeed master, but may ward off, complete ignorance of things which have little to do with your studies or your sports, but are none the less worth knowing and loving. You have college societies where such things are discussed

and debated. They are described in the excellent little pamphlet which has been put in every freshman's hand. You can at the least do what is in your power to attend and support them. You can take care that your undergraduate days do not pass without the great names of literature becoming more than names to you. Books can be had for the asking from public libraries, they can be bought for pence where they used to cost shillings. We owe to the generosity of Prof. Perry the nucleus of a college library containing books which are not scientific. He who now devotes to literary trash time which he might spend in learning something of one of the greatest literatures of the world has nobody but himself to thank if his reading vulgarises instead of refines him. Taste is educated only by tasting; and it rests with yourselves whether you will learn to appreciate the difference between the great masters of the pen and penny-a-liners, between the wit of a great humourist and the vulgarities of the funny corner of a second-rate newspaper.

A bicycle ride will be none the less enjoyable if you train yourself, not merely to travel far, but to take an interest in the sights and scenes through which you pass. For the sake of example, let me remind you that no country is so rich as England in the architecture of its village churches. It is no hard matter to learn to recognise the principal peculiarities of the architectural types which prevailed from the days of the Saxons to Sir Christopher Wren. The text-books are, I presume, to be found in the Art Library. But as soon as the elements of English church architecture are known, an old church ceases to be merely a picturesque object. It is an historical document which you yourself can read. You do not need the aid of the sexton to tell you which is the oldest part. You can make a good guess at when that aisle was added, or that window knocked in a wall obviously older than itself. A visit to a cathedral becomes an intellectual pleasure. Weariness at the drone of the verger as he recites his oft-repeated lesson is replaced by an alert desire to know if the authorities from whom he learnt it confirm or correct the rapid conclusions as to date or history to which you yourself have come.

I might multiply such examples. Nowhere in England can you so easily or so cheaply as in London hear and learn to appreciate the best music the world has produced.

The wet half holidays of an undergraduate's career well spent in the National Gallery would give you a familiarity with all the great schools of painting which few travellers attain.

Every day as you come to or leave your work you may pass through one of the greatest art collections in the world, and it depends upon you alone as to whether you shall or shall not learn anything from it.

Understand me clearly when I reiterate that I am laying down no rules. I have tried only to lay the problem before you. How to combine the proper care for pounds, shillings, and pence with the love of knowledge for its own sake; how best to balance your various studies; how to add to the concentration required for the mastery of a single subject the open eye and the refined taste which may lead you to appreciate arts which you cannot emulate, and things beautiful which you can neither copy nor produce; these are problems in which a university may help you, but can help you only if you are willing to help yourselves. I have to-day aimed at nothing more than at reminding you that each one of the mental forces we have discussed is essential to the equilibrium of intellectual life; that if you wilfully neglect any of them, or devote yourselves too exclusively to one, you will fall short, and, it may be, sadly short, of the ideal which the true university holds up to her sons.

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SECTION K.

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II.

THE second period of our history begins with the arrival in India in 1848 of Sir (then Dr.) Joseph Hooker. This distinguished botanist came out in the suite of Lord Dalhousie, who had been appointed Governor-General of India. The province to the exploration of which Sir Joseph directed his chief attention was that of Sikkim in the Eastern Himalaya, the higher and inner ranges of which had never previously been visited by a botanist, for Griffith's explorations had been confined to the lower and outer spurs. The results of Sir Joseph's labours in Sikkim were enormous. Towards the end of his exploration of Sikkim he was joined by Dr. Thomas Thomson, and the two friends subsequently explored the Khasia Hills (one of the richest collecting grounds in the world), and also to some extent the districts of Sylhet, Cachar and Chittagong. Dr. Thomson subsequently amalgamated the collections made by himself in the Western Himalaya with those made in Sikkim by Sir Joseph individually, and by them both conjointly in Eastern India; and a distribution of the duplicates after the fashion of the Wallichian issue, and second only to it in importance, was subsequently made from Kew. The number of species thus issued amounted to from 6000 to 7000, and the individuals were much more numerous than those of the Wallichian collection. The immediate literary results of Sir Joseph Hooker's visit to Sikkim were (1) his superbly illustrated monograph of the new and magnificent species of *Rhododendron* which he had discovered; (2) a similar splendid volume illustrated by plates founded on drawings of certain other prominent plants of the Eastern Himalaya which had been made for Mr. Cathcart, a member of the Civil Service of India, and (3) his classic "Himalayan Journals"—a book which remains until this day the richest repertory of information concerning the botany, geography and anthropology of the Eastern Himalaya. A remoter result was the appearance in 1855 of the first volume of a "Flora Indica," projected by himself and his friend Dr. Thomson. The first half of this volume is occupied by a masterly introductory essay on Indian botany, of which it is hardly possible to overrate the importance. This remarkable essay contains by far the most important contribution to the physico-geographical botany of India that has ever been made, and it abounds in sagacious observations on the limitation of species and on hybridisation, besides containing much information on the history of Indian botanical collections and collectors. The taxonomic part of the book was cast in a large mould, and the descriptions were written in Latin. Unfortunately, the condition of Dr. Thomson's health and the pressure of Sir Joseph's official duties at Kew made it impossible that the book should be continued on the magnificent scale on which it had been conceived. After a period of about twelve years Sir Joseph, however, returned to the task of preparing, with the aid of other botanists, a Flora of the Indian Empire, conceived on a smaller scale and written in the English language. His proposals for this work were accepted and officially sanctioned by the Duke of Argyll while he was Secretary of State for India. The first part of this great work was published in 1872 and the last in 1897. In the execution of this great undertaking Sir Joseph had the assistance of Mr. C. B. Clarke, who elaborated various natural orders; of Mr. J. G. Baker, who worked out *Leguminosae* and *Scitamineae*, and of Sir W. Thiselton-Dyer, Messrs. A. W. Bennett, Anderson, Edgeworth, Hiern, Lawson, Maxwell Masters, Stapf and Gamble. The greater proportion, however, of the book is Sir Joseph's own work, and a noble monument it forms of his devotion and genius.

[1] Continued from p. 584.

Since the date of Sir Joseph Hooker's visit to India, by far the most important botanical work done in India has been that of Mr. C. B. Clarke. Rather than attempt to give any appreciation of my own of Mr. Clarke's labours (which would be more or less of an impertinence), I may be allowed to quote from the preface to the concluding volume of the "Flora of British India" Sir Joseph's Hooker's estimate of them. Referring to all the collections received at Kew since the preparation of the "Flora" was begun, Sir Joseph writes: "The first in importance amongst them are Mr. C. B. Clarke's, whether for their extent, the knowledge and judgment with which the specimens were selected, ticketed, and preserved, and for the valuable observations which accompany them." Mr. Clarke has published numerous papers on Indian botanical subjects in the journals of the Linnean and other societies. He has issued as independent books monographs of Indian *Compositae* and *Cyrtandraceae*, the former in octavo, the latter in folio, and illustrated by many plates; and he is now engaged on his *opus maximum*, viz. a monograph of the *Cyperaceae*, not only of India, but of the whole world; and to the completion and publication of this every systematic botanist is looking forward with eager anxiety.

During this second half of the century, Dr. Thomas Anderson, who was for ten years superintendent of the Calcutta Garden, collected much; and he had just entered on what promised to be a brilliant career of botanical authorship when his life was cut short by disease of the liver, contracted during his labours to establish the cultivation in British India of the quinine-yielding species of cinchona. Dr. Anderson was also the earliest conservator of forests in Bengal. Sulpiz Kurz, for many years curator of the Calcutta Herbarium, also collected largely in Burma, and besides many excellent papers which he contributed to the *Journal* of the Asiatic Society of Bengal, he prepared for Government an excellent manual entitled the "Forest Flora of Burma." This was published in two volumes in 1877. Other collectors in Burma were Colonel Eyre (in Pegu), Mr. Burness (at Ava), and the Rev. Mr. Parish, to whom horticulturists are indebted for the introduction to Europe of the beautiful orchids of this rich province. And in this connection must be mentioned Mr. E. H. Man, C.I.E., who, although not himself a botanist, has given for many years past the greatest possible help in the botanical exploration of the Andaman and Nicobar groups of islands, our first knowledge of which was, by the way, derived from the collections made by the naturalists of the Austrian and Danish exploring expeditions. A large book on Burma, which contains a good deal of botany, was published by an American missionary named Mason, who resided for the greater part of his working life in that country. General Sir Henry Collett, who commanded a brigade during the last Burmese war, also made most interesting collections in that country, the novelties of which were described by himself in collaboration with Mr. W. Botting Hemsley, of the Kew Herbarium, in the Linnean Society's *Journal* some years ago. Sir Henry Collett also collected much in the Khasia and Naga hills, and in the portion of the North-western Himalaya of which Simla is the capital, and on these latter collections, together with the materials in Kew Herbarium, Sir Henry is now elaborating a local flora of Simla. The preparation of a local flora for an Indian district is an entirely new departure, and the publication of Sir Henry's book, which is to be well illustrated, is looked forward to with much interest. At rather an earlier period, Dr. Aitchieson was a diligent collector of the plants of the Punjab and of the North-western Frontier. Some results of his work are to be found in his "List of Punjab Plants," which was published in 1867, and in various papers which he contributed (some of them in conjunction with Mr. Hemsley) to the Linnean Society and to the Botanical Society of Edinburgh. In Dr. G. Henderson's book on Yarkand there are also descriptions of some plants of the extreme North-western Himalaya and of Western Tibet. Mr. (now Sir George) Birdwood also made some contributions to the botany of the Bombay Presidency.

Five officers of the Indian Forest Department, viz. Dr. Lindsay Stewart, Colonel Beddome, Sir D. Brandis, and Messrs. Talbot and Gamble, have within the past thirty years made important contributions to the systematic botany of India. Dr.

Stewart collected largely, and published in 1869 his "Punjab Plants," a book which gives a very imperfect impression of his acquirements as a botanist. Sir Dietrich Brandis issued in 1874 his admirably accurate "Forest Flora of the North-west Provinces of India," illustrated by seventy excellent plates. Between the years 1869 and 1873, Colonel Beddome issued his "Flora Sylvatica of the Madras Presidency," illustrated by numerous plates. He also published, between 1869 and 1874, a volume of descriptions and figures of new Indian plants, under the title "Icones Plantarum Indiæ Orientalis." Colonel Beddome is the only Indian botanist of note, except Griffith, Mr. C. B. Clarke and Mr. C. W. Hope, who has written much on Indian ferns. His two works, the "Ferns of Southern India" and the "Ferns of British India," published the former in 1863 and the latter between 1865 and 1870, practically give a systematic account, together with excellent figures, of the whole fern flora of India. Of these excellent books a condensation in a popular and abridged form has also been issued. The fourth forest officer who has published contributions to systematic botany is Mr. W. A. Talbot, whose "List of the Trees, Shrubs and Woody Climbers of the Bombay Presidency" gives evidence of much careful research. And the fifth is Mr. J. S. Gamble, who, besides amassing at his own expense probably the largest private collection of plants ever owned in India, has published a systematic account of the Indian *Bambuseae*, a tribe of grasses which, from the peculiarity of many of the species in the matter of flowering, had so long been the bane of the Indian agrostologist. Mr. Gamble, in his monograph, gives a description and a life-sized figure of every one of the Indian species. Of this monograph (which forms a volume of the "Annals of the Botanic Garden, Calcutta") Sir Joseph Hooker writes (at p. 375. vol. vii. of his "Flora of British India"): "It is indispensable to the student of the tribe by reason of its descriptions and admirable plates and analyses." Mr. Gamble has also published a Manual of Indian Timbers. A forest officer who was ever ready to help in botanical work, but who never himself published, was Mr. Gustav Mann, for many years Conservator of Forests in Assam, but now lost to India by his premature retirement. Other forest officers, who have done, and are still doing, good botanical work in their various spheres, are Messrs. Lace, Heinig, Haines, McDonell, Ellis, Oliver, and Upendra Nath Kanjilal. Mr. Bourdillon, conservator of forests in the Travancore State, is also an enthusiastic botanist and collector.

In the Madras Presidency botanical work has been carried on during this second half of the century by Noton, Perrottet, Metz, Hohenacher, Schmidt (on the Nilgiris), Bidie and Lawson. By the efforts of the latter two, a second public herbarium was established in Madras (the first having been broken up many years ago), and in this second Madras herbarium are to be found many of the collections of Wight, besides those of the other Madras botanists just named.

In the Bombay Presidency, the only public herbarium is at Poona. This is of recent origin, and owes its existence to the devotion of four men, viz. Dr. Theodore Cooke (late principal of the College of Science at Poona), Mr. Marshall Woodrow (until recently superintendent of the garden at Guneshkind and lecturer in botany in the Poona College), the late Mr. Ranade (a native gentleman), and Dr. Lisboa (a medical practitioner in the Deccan)—all four enthusiastic botanists. The amount of Government support given to the herbarium at Poona has hitherto been very inadequate. It is to be hoped that greater liberality may be extended to it now that a stranger to the Bombay Presidency has just been appointed to its charge in the person of Mr. George Gammie, hitherto employed in the cinchona department of Bengal.

Reference has already been made to the botanic gardens at Seharunpore and Calcutta. But to complete this sketch, and especially in order to give a clear idea of the apparatus at present existing in India for carrying on the study and practice of systematic botany, it is necessary again to refer to them. On the retirement of Dr. Jameson in 1872, Mr. J. F. Duthie was selected by the Secretary of State for India as superintendent of the Seharunpore garden. Mr. Duthie is still at Seharunpore. During his tenure of office he has added to the herbarium previously existing there (which consisted chiefly of the collections of Royle, Falconer and Jameson) a magnificent collection of his own. Mr. Duthie has published a valuable book on the "Field and Garden Crops of the North-western Provinces," and another on the grasses of the same area. He is now engaged on the preparation of local floras of the North-west Provinces and of the Punjab.

The Calcutta Garden at the date of Sir J. D. Hooker's arrival in India in 1848 was under the charge of Dr. Falconer, who, in 1855, was succeeded by Dr. J. Thomson, and he in turn by Dr. T. Anderson in 1861. Mr. C. B. Clarke acted as superintendent during the interregnum between Dr. Anderson's lamented death in 1870 and my own appointment in 1871. The garden and herbarium at Calcutta have been most liberally supported by the Government of Bengal. By funds thus supplied the garden has been remodelled and improved; the herbarium has been housed in an excellent fire-proof building (erected in 1883), and the collections of which it consists have been greatly increased. The chief items of these later acquisitions have been the large contributions of Mr. C. B. Clarke; of Dr. D. Prain, for many years curator of the herbarium, and now superintendent of the garden and of the cinchona plantation and factory; of Mr. G. A. Gammie, formerly one of the staff of the cinchona plantation, and now lecturer on botany in the College of Science at Poona; of Mr. R. Pantling, deputy-superintendent of the cinchona plantation, who, in addition to dried specimens of the orchids of Sikkim, contributed nearly five hundred drawings, most of which have been lithographed as the illustrations to a book published in the "Annals" of the garden, as the "Orchid Flora of Sikkim"; of Mr. Kunstler, a collector in the Malay Peninsula; and last, but by no means least, of a trained band of aborigines of Sikkim named Lepchas who possess keener powers of observation of natural objects, more patience, sweeter tempers, and, I am bound in fairness to add, dirtier clothes than any race I have ever met—black, yellow, or white! In addition to their liberal grants to the garden and herbarium, the Bengal Government, twelve years ago, sanctioned the publication, at their expense, as occasion might offer, of monographs of important families or genera of Indian plants. These monographs are printed in quarto, and they are, with one exception, profusely illustrated by plates drawn and lithographed by Bengali draughtsmen. The series is known as "The Annals of the Royal Botanic Garden, Calcutta," and it has now reached its eighth volume, the ninth being in active preparation. These "Annals" have been contributed to by Dr. Prain (my successor at the Calcutta Garden), by Dr. D. Douglas Cunningham, Mr. J. S. Gamble, Mr. R. Pantling, and myself.

About ten years ago, it occurred to the Supreme Government of India that it might be to the interest of science if the four botanical establishments at Calcutta, Seharunpore, Madras, and Poona were to be formed into a kind of hierarchy under the designation of the Botanical Survey of India, without removing either the officers or the four institutions to which they were attached from the financial or general control of the local administrations within which they are respectively situated, the Supreme Government making a small contribution of money for the purpose of exploring little-known districts and making itself responsible for the cost of a publication called "The Records of the Botanical Survey." The four institutions just mentioned continue, therefore, to be paid for and controlled by the Governments of Bengal, the North-west Provinces, Madras and Bombay, but their superintendents are placed on the cadre of the Botanical Survey. The published Records of this Survey now extend to twelve numbers, each of which is devoted to an account of the botany of some part of the enormous and continually expanding area to be explored.

Such, then, is the machinery by which systematic, as distinguished from economic and physiological, botany is carried on within the Indian Empire. But the work done in India itself by no means represents all the work that is being carried on in connection with the elucidation of the flora of the Empire of India. On the contrary, the bulk of the work of elaborating the materials sent from India in the shape of dried specimens has always been, and must always be, done in a large herbarium; and until lately no herbarium in Asia has been sufficiently extensive. The last word on every difficult taxonomic question must still lie in Europe. A very large number of the herbarium specimens collected in India have found their way to the various centres of botanical activity in Europe, and have been described by botanists of many nationalities. The lion's share of these specimens has naturally come to the two great national herbaria in the British Museum and at Kew, but especially to the latter. It was in the Kew Herbarium that Sir Joseph Hooker and his collaborateurs prepared the flora of

British India. And it is in the Kew Herbarium that are to be found the types of an overwhelming proportion of the new species described for the first time in that monumental work. The Kew Herbarium is therefore to the Indian botanist the most important that exists. I must apologise for diverging for a moment to remind you what a type specimen is. It is the very one on which an author has founded any species to which he has given a name. And in order to determine absolutely what is the specific form to which the author meant his name to apply, it is often necessary to examine his type. This necessity increases in urgency with the extension of our knowledge of the flora of the world.

The preservation in good condition of a type specimen is therefore, from the point of view of a systematic botanist, as important as is the preservation to the British merchant to the standard pound weight and the standard yard measure on which the operations of British commerce depend. "Types" also stand to the systematic botanist much in the same relation as the national records do to the national historian. The latter are guarded in the Record Office, I understand, with all the skill which the makers of fire-proof, damp-proof and burglar-proof depositories can suggest. If, however, the type of a species happens to be deposited at Kew, what are the probabilities of its preservation? Such a type at Kew is incorporated in what is admittted to be in every sense the largest and, for its size, the most accurately named, the most easily consulted, and therefore the most valuable herbarium in the world, the destruction of which would be a calamity commensurate in extent with that of the burning of the library at Alexandria. One might therefore reasonably expect that a people who rather resent being called a "nation of shopkeepers" would feel pride in providing for this priceless national collection a home which, although perhaps somewhat inferior to that provided for the national historical records, might at least be safe from fire. This expectation is not fulfilled. The infinitely valuable Kew Herbarium and library have no safer home than an old dwelling-house on Kew Green, to which a cheap additional wing has been built. The floor, galleries and open inner roof of this additional wing are constructed of pine coated with an inflammable varnish, and on the floor and galleries are arranged cabinets (also made of pine-wood) in which the specimens (which are mounted on paper) are lodged. The provision of a fireproof building, capable of expansion as the collections extend, is surely not beyond the means of an exchequer which last year netted over one hundred and six millions sterling of revenue. On behalf of the flora of India, I venture to express the hope that the provision of a proper home for its types may receive early and favourable consideration by the holders of the national purse-strings. But India is by no means the only portion of the Empire interested in this matter, for the types of the Australasian floras, those of a large part of the North American flora, and those of many species inhabiting countries outside British rule or influence, find their resting-place at Kew. The safe custody of the Kew Herbarium is, therefore, not merely a national, but a cosmopolitan responsibility.

In this Address I have hitherto made little reference to cryptogamic and economic botany. As regards cryptogamic botany there is little to relate. Except Griffith, no Indian botanist of the earlier of the two periods into which I have divided my sketch ever did any serious work amongst non-vascular cryptogams. During the second period two men have done gallant work under difficulties which no one who has not lived in a tropical country can thoroughly appreciate. I refer to Drs. Arthur Barclay and D. D. Cunningham. The former made some progress in the study of uredinous fungi, which was cut short by his untimely death; while the latter, in addition to his bacterial and other researches connected with the causation of human disease, conducted protracted investigations into some diseases of plants of fungal or algal origin. Some of the results of Dr. Cunningham's labours were published in the *Transactions* of the Linnean Society, and in a series entitled the "Scientific Memoirs, by Medical Officers of the Indian Army." To the "Annals of the Botanic Garden, Calcutta," Dr. Cunningham also contributed elaborate memoirs on the phenomena of nyctitropism, and on the mode of fertilisation in an Indian species of Ficus (*F. Roxburghii*). There is no doubt that, in the past, cryptogamic botany has not been studied in India as it ought to have been and might have been. This discredit will, I hope, be soon removed; and I trust that, by the time the twentieth century opens, a cryptogamist may have been appointed to the staff of the Calcutta Botanic Garden. The collecting of cryptogams was not, however, altogether neglected in India in times past. For, from materials sent to England, Mitten was able to elaborate a moss flora of India, while Berkeley and Browne were enabled to prepare their account of the fungi of Ceylon. George Wallich, in whom the botanical genius of his father burnt with a clear though flickering flame, did some excellent work amongst Desmids, and was among the earliest of deep-sea dredgers.

Economic botany has, on the other hand, by no means been neglected. It was chiefly on economic grounds that the establishment of a botanic garden at Calcutta was pressed upon the Court of Directors of the East India Company. And almost every one of the workers whose labours I have alluded to has incidentally devoted some attention to the economic aspect of botany. Roxburgh's "Flora Indica" contains all that was known up to his day of the uses of the plants described in it. Much of Wight's time was spent in improving the races of cotton grown in India. The botanists of the Seharunpore garden during the middle of the century were especially prominent in this branch of botanical activity. Royle wrote largely on cotton and on other fibres, on drugs, and on various vegetable products used, or likely to be of use, in the arts. These botanists introduced into the Himalayas more than fifty years ago the best European fruits. From gardens which owe their origin to Royle, Falconer and Jameson, excellent apples grown in Gharwal and Kamaon are to-day purchasable in Calcutta. Peaches, nectarines, grapes, strawberries, of European origin, are plentiful and cheap all over the North-west Himalaya, and are obtainable also in the submontane districts. Potatoes, and all the best European vegetables, were introduced long ago; and at Seharunpore there is still kept up a large vegetable garden from which seeds of most European vegetables are issued for cultivation during the cold season in the gardens of the various regiments of the Queen's troops quartered in Upper India. More or less attention has been given in the past by Government botanists in India generally to the improvement of the cultivation of flax, hemp, rheea, tobacco, henbane, dandelion, vanilla, sarsaparilla, coffee (Arabian and Liberian), cocoa, ipecacuanha, aloes, jalap, india-rubber, Japanese paper-mulberry, cardamoms, tapioca, coca, tea and cinchona. Only to three economic enterprises, however, have I time to allude in any detail. These are (1) the cultivation of tea, (2) the introduction of cinchona, and (3) the formation of the Forest Department. But before proceeding to the consideration of these I wish to give a short account of the inauguration of the office of Reporter on Economic Products. Up to the year 1883 there had been no special Government department in India for dealing with questions connected with the natural products of the Empire. Whatever had been done prior to that date (and the amount was by no means unimportant) had been the result of isolated and uncoordinated effort. In 1883 the Government of India founded a department for dealing with the economic products of the Indian Empire, and under the title of Reporter on these products they were fortunate enough to secure Dr. George Watt, a member of the Bengal Educational Service. Dr. Watt is an accomplished and able botanist. He has collected Indian plants largely, and has made numerous notes both in the field and in the bazaar. The great work which, on the initiative of Sir Edward Buck, Secretary to the Department of Revenue and Agriculture, and of Sir W. Thiselton-Dyer, of Kew, Dr. Watt began and carried to a successful termination was the compilation of his "Dictionary of Economic Products," in which valuable book is collected all that is known of almost every Indian product, whether vegetable, animal or mineral. The study of economic botany is now pursued in India as part of a highly specialised system of inquiry and experiment. Dr. Watt has a competent staff under him in Calcutta, one of whom is Mr. D. Hooper, well known for his original researches into the properties of various Indian drugs. Dr. Watt has arranged in Calcutta a magnificent museum of economic products, and there is no doubt the economic resources of the Empire are now being studied with as much energy as intelligence.

Tea cultivation is one of the enterprises in the introduction and development of which botanists took a very leading part. The advisability of introducing the industry was first pressed on the attention of the East India Company by Dr. Govan (of Seharunpore), and in this he was seconded by Sir Joseph Banks as President of the Royal Society. Royle in 1827, and Falconer

slightly later, again urged it as regards the North-west Himalaya. In 1826 David Scott demonstrated to rather unwilling eyes in Calcutta the fact that real tea grows wild in Assam. In 1835 Wallich, Griffith and McClelland were deputed by Government to visit Assam, to report on the indigenous tea. In the year 1838 the first consignment of Indian-grown tea was offered for sale in London. The consignment consisted of twelve chests containing 20 lbs. each. This first sample of 240 lbs. was favourably reported upon. Last year the exports of tea from India to all countries reached 157 millions of pounds, besides 120 millions of pounds exported from Ceylon!

The introduction of cinchona into India originated purely with the Government botanists. As everybody knows, quinine, and to a less extent the other alkaloids present in cinchona bark, are practically the only remedies for the commonest, and in some of its forms one of the most fatal, of all Indian diseases, viz. *malarious fever*. The sources of supply of the cinchona barks in their native countries in South America were known to be gradually failing, and the price of quinine had for long been increasing. The advisability of growing cinchona in the mountains of British India was therefore pressed upon Government by Dr. Royle in 1835, and he repeated his suggestions in 1847, 1853 and 1856. Dr. Falconer, in his capacity of superintendent of the Botanic Garden, Calcutta, made a similar suggestion in 1852; and his successors at Calcutta, Dr. T. Thomson and Dr. T. Anderson, in turn advocated the proposal. In 1858 Government at last took action, and, as the result of the labours of Sir Clements Markham and Sir W. J. Hooker, of Kew, the medicinal cinchonas were finally, in the period between 1861 and 1865, successfully introduced into British India—on the Nilgiris under Mr. McIvor, and on the Sikkim-Himalaya under Dr. T. Anderson. Various experiments on the best mode of utilising the alkaloids contained in red cinchona bark resulted in the production in 1870 by Mr. Broughton, quinologist on the Nilgiri plantation, of an amorphous preparation containing all the alkaloids of that bark. This preparation was named *Amorphous Quinine*. Somewhat later (1875) a similar preparation, under the name of *Cinchona Febrifuge*, was produced at the Sikkim plantation by Mr. C. H. Wood, the quinologist there; and of these drugs about fifty-one tons have been distributed from the Sikkim plantation up to the end of last year. The preparation of pure quinine from the yellow cinchona barks, so successfully grown in the Sikkim plantation, long remained a serious problem. The manufacture of quinine had hitherto been practically a trade secret. And when the Indian Government had succeeded in providing the raw material from which a cheap quinine might be made for distribution amongst its fever-stricken subjects, the knowledge of the means of extracting this quinine was wanting. Philanthropic platitudes were freely bandied about as to the immensity of the boon which cheap quinine would be to a fever-stricken population numbering so many millions. But there was a singular absence of any practical help in the shape of proposals, or even hints, as to how quinine was to be extracted from the rapidly increasing stock of crown and yellow bark. The officers in charge of the cinchona plantations in India had therefore to do their best to solve the problem for themselves. And it was ultimately solved by Mr. C. H. Wood, at one time Government quinologist in Sikkim, who suggested, and Mr. J. A. Gammie, deputy-superintendent of the plantation there, who carried into practice, a method of extraction by the use, as solvents of the cinchona alkaloids, of a mixture of fusel-oil and petroleum. The details of this process were published in the *Calcutta Official Gazette*, for the benefit of all whom it might concern. Very soon after the introduction of this method of manufacture, the Government factories in Sikkim and the Nilgiris were able to supply the whole of the Government hospitals and dispensaries in India with all the quinine required in them (some 5000 or 6000 pounds annually), besides providing an almost equal quantity for the supply of Government officers for charitable purposes. The latest development of the quinine enterprise in India has been the organisation of a scheme for the sale at all the post-offices in the province of Bengal, and in some of those of Madras, of packets each containing five grains of pure quinine, that being a sufficient dose for an ordinary case of fever in a native of India. These packets (of which some are on the table for distribution) are sold at one pice each, the pice being a coin which is equal, at the current rate of exchange, to one farthing sterling!

In conclusion, I wish to make a few remarks on the third great economic enterprise connected with botany in India, viz. the Forest Department. The necessity for taking some steps to preserve a continuity of supply of timber, bamboos and other products from the jungles which had for generations been exploited in the most reckless fashion, was first recognised by the Government of Bombay, who in 1807 appointed commissioners to fix the boundaries of and to guard the forests in that Presidency. This scheme was abandoned in 1822, but was resumed in a modified form during 1839–40. Seven years later a regular forest service was established in Bombay, and Dr. Gibson was its first head. Dr. Gibson in turn was succeeded by Mr. Dalzell—and both were botanists. In the Madras Presidency the first man to recognise the necessity of perpetuating the supply of teak for ship-building was Mr. Connolly, collector of Malabar, who in 1843 established a teak plantation at Nelumbur, which has been carried on, and annually added to, down to the present time. In 1847 Dr. Cleghorn (a botanist) was appointed to report on the conservation of the forests of Mysore (which contained the well-known sandal-wood), and the following year Lieutenant Michael (still with us as General Michael, a hale and hearty veteran) was appointed to organise and conserve the public forests in Coimbatore and Cochin. The crowning merit of General Michael's administration was the establishment, for the first time in India, of a system of protection against the fires which annually used to work such deadly havoc. In 1850 the British Association, at their Edinburgh meeting, appointed a committee to consider and report upon the probable effects, from an economic and physical point of view, of the destruction of tropical forests. This committee's report was submitted to the Association at the meeting at Ipswich in 1851. The weighty evidence collected in this report so impressed the Court of Directors of the East Indian Company that, within a few years, regular forest establishments were sanctioned for Madras and British Burma, the two main sources of the supply of teak.

In 1856 Mr. (now Sir Dietrich) Brandis was appointed to the care of the forests of the latter province. These forests had been the object of spasmodic efforts in conservancy for many years previously. In 1827 Dr. Wallich reported on the teak forests, and five years later a small conservancy establishment was organised, officered by natives. This, however, was kept up for only three or four years. In 1837 and 1838 Dr. Helfer reported on these forests, and an English conservator was appointed. In 1842 and 1847 codes of forest laws were drawn up, but do not appear to have been enforced to any extent. In 1853 Dr. McClelland was appointed superintendent, but he continued to hold the office for only a short time. A few years after Sir Dietrich Brandis's assumption of the charge of the Burmese forests, he was appointed Inspector-General of all the Government forests in British India; and it is to him that we owe for the most part the organisation of the Indian Forest Department as it now exists. That organisation includes two schools of forestry (in both of which botany is taught), one in connection with Coopers Hill and the other at Dehra Dun in Upper India. The latter has for many years been under the direction of a gentleman who is distinguished both as a forester and as a botanist. In the Coopers Hill School the higher grades of forest officers receive their training; at Dehra Dun those of the lower grades receive theirs. The officers of the department on the Imperial list, according to the latest official returns, now number 208, divided into the grades of conservator, deputy- and assistant-conservator, with a single inspector-general as chief. In addition to these, there are 566 provincial officers, ranking from rangers upwards to extra deputy-conservators.

Botanists took a leading part in moulding the department in its earlier years; for, as already stated, its pioneers—Gibson, Dalzell, Cleghorn, Anderson, Stewart and Brandis—were all botanists. And to most people, who give even casual attention to the matter, it appears fitting that the possession of a knowledge and liking for botany should form a strong characteristic of officers whose main duties are to be in the forest. And this belief did for some time exercise considerable influence in the selection of recruits for the department. But, except in the Dehra Dun School, it does not appear to guide the department any longer. For example, at the entrance examination to the Forest School at Coopers Hill, only three subjects are obligatory for a candidate, viz. mathematics, to which 3000 marks are allowed; German, to which 2000 are allowed; and English, for which 1000 are given. Botany is one of the nine optional

subjects, of which a candidate may take up two, and in each of which 2000 marks may be made.

Botany is taught at Coopers Hill, and (according to the Calendar of the College) it forms one of the "special auxiliary subjects" for the forest student. I do not wish to say a single word in depreciation of the botanical teaching at this college, which is probably excellent of its sort. I do not know what value, as part of their professional equipment, students are accustomed or encouraged to attach to the possession of the means of acquiring a knowledge of the trees and shrubs in the midst of which they are to pass their lives in India. But this I do know, that the ordinary forest officer educated in England now arrives in India without sufficient knowledge to enable him to recognise from their botanical characters the most well-marked Indian trees. To tell such an officer the name of the natural family to which a plant belongs conveys no information to him whatever, for he knows nothing of botanical affinities. Moreover, the forest officer after he has arrived in India is not encouraged to familiarise himself with the contents of the forests under his charge. This will be better appreciated by giving an example than by any number of remarks. Some three years ago. Mr. J. S. Gamble (a forest officer) published a monograph of the bamboos of British India. From bamboos, as you may possibly be aware, a very large amount of forest revenue is annually derived. The sales of bamboos for the year 1896-97 amounted to no less than 110 millions of stems. A great number of the species of bamboos have the curious habit of flowering gregariously at remote intervals of thirty or forty years, and the flowering is followed by death. The absence from the forests for years in succession of flowers of a number of the species, and the similarity of many of them in leaves, had hitherto made members of the group most difficult of identification. Mr. Gamble had devoted himself to their study for many years. He had carefully examined all the previously collected materials stored in the herbaria at Kew, the British Museum, Calcutta and elsewhere; and large special collections had been made for him by Mr. Gustav Mann and other officers of the Government. Moreover, he had General Munro's great paper in the Linnean *Transactions* as a basis. Mr. Gamble's work was undertaken with the full approval of Sir Joseph Hooker, who indeed accepted Mr. Gamble's account of the bamboos for his "Flora of British India." Mr. Gamble's monograph is illustrated by a life-sized drawing of each species, with analyses of the flowers on a larger scale. When completed, the book was published as one of the volumes of the "Annals of the Calcutta Botanic Garden." In consideration of the supposed great importance of the book to the forester, and in the belief that the copies would be eagerly taken by the Forest Department, an extra hundred copies were printed, and these hundred copies were put into stout canvas binding suitable for camp use. These copies, or as many of them as he cared to take, were offered to the head of the Forest Department in India at the reduced price of fifteen rupees per copy. The result was an official refusal to buy a single one, although the purchase of the whole hundred (which was not asked for) would have cost only fifteen hundred rupees—a sum which would have reduced the revenue of the year by about one twelve-thousandth part! An appeal against this ruling having been made to a still higher authority, a modified order was subsequently issued permitting such forest officers as desired to possess the book to buy copies and charge the cost in their office expenditure. I may state that the book was not a private venture. It was produced at the expense of the Government of Bengal.

It is not because I like to play the censor that I have made these remarks about the Forest Department. Having myself served in it from 1869 to 1871, I can speak from my own experience as to the value, from the utilitarian point of view, of a knowledge of the names, affinities and properties of the trees, shrubs and herbs which compose an Indian jungle, and of a knowledge of these as individual members of the vegetable kingdom rather than as masses of tissue to be studied through a microscope. The appointment which I held in India for twenty-six years after leaving the Forest Department gave me full opportunity of getting into touch with all who interest themselves in a knowledge of plants, and of discovering how few of these at the present day are forest officers. The majority of the latter, if they love their trees, are content to do so without knowing their names or relationships! There are, of course, splendid exceptions who know as well as love. The general decadence of the teaching of systematic botany in England during the past twenty years is, perhaps, to some extent the cause of the low estimation in which the science is held by the authorities of the Indian Forest Department. Twenty-five years ago systematic and morphological botany, no doubt, had too great prominence given to them in the teaching at universities and colleges of this country, and the other branches of botanical science were too much neglected, although I do not think they were despised. Now it appears to me that systematic botany is too much neglected. I hope it is not also despised! Few of the systematists who survive in England are now to be found attached to the universities. They are mostly clustered round the two great herbaria in London; and such of them as have to look to systematic botany for the means of livelihood are not in the receipt of salaries such as one might reasonably expect in one of the richest countries in the world!

CHEMISTRY AT THE BRITISH ASSOCIATION.

DESPITE the fact that the Dover meeting was a comparatively small one, the chemists formed a thoroughly representative gathering, including amongst distinguished foreigners Prof. Lemoine, of Paris; Prof. Fittig, of Strassburg; and Prof. Ladenburg, of Breslau. The able address of the President, Dr. Horace T. Brown, on the assimilation of carbon by the higher plants, which embodied most valuable and original contributions to the knowledge of the complex changes which go on in the living cell, introduced a subject somewhat beyond the usual scope of the proceedings of the Section; and whilst the chemists present at Dover will always look back upon the address with a special appreciation, they will be equally mindful of the many interesting contributions on kindred subjects for which the personality of the President was in the main responsible. Prof. Hanriot, the President of the Chemical Section of the French Association, communicated a short account of the excretory products of plants, in which he discussed the mutations of nitrogen in the vegetable kingdom as based on his own observation of the occurrence of asparagine amongst the secretions of plant roots; when passed into the soil this product would in all probability become oxidised to nitrates, and thus become directly available for plant life. The experimental confirmation of this view is in course of study. The chemical processes involved in the saccharification of starch by malt-diastase were discussed by Dr. A. Fernbach, of the Institut Pasteur, and by Dr. G. H. Morris. The former detailed his observations on the influence of acids and of some salts on saccharification, which led him to the conclusion that the slightest trace of any free acid retards the action of diastase on gelatinised as well as on soluble starch, provided both the starch and diastase are free from salts on which the added acid may act; but if the solution contains salts, such as secondary phosphates, which are distinctly unfavourable to diastatic action, the addition of acid is favourable as long as there is no excess over the quantity necessary to transform these salts into the primary phosphates. The President regarded these results as opposed to his own observations on the subject, and considered further details of the experiments necessary to justify the conclusions. Dr. G. H. Morris, in a paper on the combined action of diastase and yeast on starch granules, showed that similarly to the symbiotic action of diastase and yeast on the so-called stable dextrin, ungelatinised intact starch granules, when submitted to the joint action of diastase and yeast, are fermented to a large extent, the maltose first formed being converted into alcohol. The addition of a small quantity of yeast to a cold water malt extract more than doubles the percentage of starch that is changed, and this increased action is not due to any greater activity of the diastase that might result from the removal of the soluble product formed (maltose) from the sphere of action. It appears necessary to have both the diastase and the yeast present together in a condition capable of exercising their respective functions for the increased action to occur. The action of acids on starch was also discussed by Dr. Morris, who showed that maltose is always obtained as a product of hydrolysis together with dextrin and dextrose; this is in opposition of H. Johnson's statement that the two latter compounds are the sole products of the action. But the most interesting contribution to this branch of chemistry was the joint discussion with Section K (botany) on symbiotic fermentation, on the occasion of the visit of the French Association. The discussion

was opened by Prof. Marshall Ward, who was followed by Sir Henry Roscoe, Prof. Armstrong, M. van Laar, Prof. Reynolds Green, Prof. Warington, M. Tanret, Prof. Francis Darwin and Dr. G. H. Morris. There is little doubt that the discussion has led to a more exact recognition of the division and relations of symbiotic changes, which should serve to develop the study of the subject. Prof. Marshall Ward, after considering the conditions under which symbiosis exists both in the vegetable and animal kingdoms, passed to the more special subject of symbiotic fermentations. Prof. Ward instanced the various grades of symbiotic association that may be recognised, suggesting a special nomenclature, and concluded his remarks with the consideration of the physiology of the subject. The many possibilities that may arise in the mutual life of symbiotic organisms—such as the provision of definite food material by one symbiont for the other, or the advantage derived from a protective influence, or, finally, the exertion of a stimulating action—were discussed, with the conclusion that there is some evidence to support the hypothesis that one symbiont may stimulate another by excreting a body which acts as an exciting drug to the associated organism. The chemical aspect of the subject was concisely treated by Prof. Armstrong, who pointed out that there is an absence of positive evidence to show that one member of a pair of symbiotic organisms does more than prepare the way for the other by effecting a change which the second is incapable of inducing. The possibility of chemical interaction playing a part in symbiotic changes and the hydrolytic function of enzymes were clearly brought out, and illustrations of allied changes of a purely chemical character instanced. Prof. Armstrong pointed out that no case has yet been observed in which a substance is attacked by a pair of organisms neither of which can attack it singly, and regarded it as probable that associated molecules undergo change under the influence of a single organism or agent which determines their association. Prof. van Laar, on the other hand, expressed the view that symbiosis was rather a case of parasitism. Dr. Calmette's contribution on industrial symbiotic fermentations was read, in his unavoidable absence, by Sir Henry Roscoe. In this paper an account was given of the methods for the conversion of starch into alcohol by the association of pure cultures of moulds with pure yeast cultures, and the industrial application of this symbiotic relation. Both in France and in Belgium thousands of tons of starch are now converted into alcohol by this method, and most favourable results have been obtained both as regards yield and quality. In inorganic chemistry Prof. Dewar's important experiments on the solidification of hydrogen stands foremost; an account of these researches has already appeared in NATURE. Colonel Waterhouse contributed a note on a remarkable result he has observed on the exposure of metallic silver to light; a visible image results on the exposed plate after prolonged exposure, but the effect may be recognised in a very much shorter space of time by the development of the latent image produced. An important discussion on the proposal of establishing an International Committee on Atomic Weights was initiated by Prof. F. W. Clarke in the form of a letter to Prof. Tilden, who himself contributed a critical *résumé* of both the theoretical and practical aspects of the question. In view of the proposed discussion of the subject at the Congress of Chemists to be held in Paris next year, Prof. Clarke's proposal for an International Committee aroused much interest; but the exact scope of its work appeared difficult to define in the minds of Sir Henry Roscoe, Prof. Fittig, Sir William Crookes and others who participated in the discussion. The desirability of encouraging all capable of undertaking the redetermination of atomic weights was fully recognised, but such work could not be ordered. This view, of course, referred to the theoretical part of the problem; Prof. Tilden's suggestion regarding the desirability of an understandIng as to the numbers to be chosen for ordinary use was somewhat lost sight of by many of the speakers, especially his important addendum that the values arrived at in atomic weight determinations are obtained under conditions which cannot be observed in daily laboratory practice, and that the adoption, therefore, of numbers regarded as the most exact does not of necessity contribute to the exactness of ordinary analytical observations. Dr. Gladstone's report on the teaching of natural science in elementary schools was followed by an interesting discussion; Dr. Gladstone, in conjunction with Mr. Hibbert, also contributed a paper dealing with some peculiarities in the drying of colloids such as the hydrates of silica, tin, titanium, iron and alumina.

The papers, reports, and discussions dealing with organic chemistry were of more than usual importance. Prof. Hartley read the first report of his committee on the absorption spectra and chemical constitution of organic substances, which, in addition to the work of the committee, contains a valuable summary of that of other investigators. The committee on the action of light upon dyed colours issued their final report, which completes a long series of important experiments carried out chiefly by Prof. Hummel. Prof. Armstrong opened a discussion on laws of substitution, especially in benzenoid compounds, in which the conditions of substitution in amines and phenols were dealt with. The course of the reaction in those cases in which ortho- and para-compounds, on the one hand, and essentially meta-compounds, on the other, result were discussed, and the possibility of the formation of intermediate products in the former case which subsequently undergo isomeric change fully considered. Prof. Armstrong also contributed papers on the relative orienting power of chlorine and bromine, and on isomorphism in benzene sulphonic derivatives. Extremely interesting isomorphous relations have been observed amongst these latter compounds, and a committee was appointed by the Section for their further investigation. Mr. Fenton read a summary of his researches on oxidation in presence of iron, in which the extension of his reaction to tartronic, lactic, glyceric and malic acids was referred to, and, in conjunction with Mr. Jackson, described the condensation products obtained from glycollic aldehyde under the influence of dilute alkali. β-Acrose appears to be formed when a 1 per cent. solution of caustic soda is used, whilst a starch-like product results when the aldehyde is heated to 160°–170°. Messrs. Morrell and Crofts gave an account of further experiments on the action of hydrogen peroxide on carbohydrates in presence of iron salts, the most interesting result obtained being the formation of a dibasic six-carbon atom acid from glucosone. Special interest centred in a paper by Mr. W. J. Pope on the influence of solvents on the optical activity of organic compounds, in which he traced the variations in the specific rotation of an optically active substance dissolved in various solvents to the degree of association of the active compound, and on this association factor founded a method for determining whether a particular optically active substance forms a liquid racemic compound with its optical antipode. Mr. Pope also described a new method for resolving racemic oximes into their optically active components, and Dr. M. O. Forster gave an interesting account of his researches on the influence of substitution on optical activity in the bornylamine series. Dr. Forster also described some new derivatives of camphoroxime, the chief interest of which lies in their relation to certain oxidation products of camphor. Dr. C. A. Kohn and Dr. W. Trantom, in a paper on the action of caustic soda on benzaldehyde, showed that, in the absence of water or in the presence of an excess of aldehyde, benzyl-benzoate is formed as a product of the decomposition; its production points to the formation of an intermediate ortho-compound in the reaction commonly employed in the preparation of benzyl alcohol. Prof. Emerson Reynolds described some new silicon compounds obtained by the action of ethyl mustard oil on silico-phenyl-di-imide, and Prof. Ladenburg read a summary entitled "The development of chemistry in the last fifteen years," in which the advances of the various branches of the science during that period were dealt with. Of more general interest was a paper by Prof. Clowes on intermittent bacterial treatment of raw sewage in coke beds, which was followed by one by Mr. W. Scott-Moncrieff on the place of nitrates in the biolysis of sewage. Both papers, as well as the report of the committee on water and sewage examination results, led to an interesting and useful discussion. In a paper on the chemical effect on agricultural soils of the salt-water flood of November 29, 1897, on the East Coast, by Messrs. T. S. Dymond and F. Hughes, the remarkable result was recorded that although the proportion of salt left on the soil was insufficient to prove injurious to the growing crops, the earth-worms in the soil were entirely removed, with the consequence that very few crops were worth harvesting the following year. This year nine-tenths of the salt originally present has disappeared from the soil, and young worms have again made their appearance, but still the condition of the soil remains unsatisfactory, the rate of percolation of water through the flooded soil being only half as rapid as through the unflooded. This the authors trace to the action of the chlorides of the sea water on the double silicates of the soil with the formation of silicate of alumina in a gelatinous condition.

GEOLOGY AT THE BRITISH ASSOCIATION.

ABANDONING on this occasion the customary procedure of opening the proceedings with the presidential address, Section C plunged at the first meeting into the midst of its work with a long list of papers. The reason for this change was that Sir Archibald Geikie's address might be heard on Saturday by the visiting members of the French Association between their reception in the Town Hall and their entertainment at luncheon in the College Close. The arrangement proved highly successful, and the President's eloquent demand that geologists should be allowed to investigate the duration of geological time for themselves with data at their command, unhampered by the vague speculations in which the physicists have indulged, was listened to by a crowded audience, the platform being occupied by a distinguished group of British and foreign men of science.

As befitted their importance and local interest, the first papers taken on Thursday were those relating to Coal-exploration in Kent. Mr. R. Etheridge dealt at some length with the relations between the Dover and Franco-Belgian Coal-basins, without, however, adding much new information to what is already known. Prof. W. Boyd Dawkins, after once more reviewing the history of the discovery, gave some valuable data respecting the boring carried on under his supervision at Ropersole, eight miles north-west of Dover, where Coal-measures have been struck at a depth of 1580 feet, after Chalk, Gault, Lower Greensand, Wealden, Corallian, Oxfordian, Bathonian and Liassic strata had been passed through, and respecting other borings at Ottinge, Hothfield, Old Soar near Tonbridge and Penshurst, of which the first, at a depth of 730 feet, is in Kimeridge Clay; the second, at 800 feet, in Portlandian beds; the third, at over 700 feet, in Hastings Sands; and the last, at 1867 feet, in Kimeridge Clay. From these data, Prof. Dawkins concludes that the southern boundary of the concealed coal-basin ranges under the southern scarp of the North Downs for some distance to the westward of Dover, along the line marked by the Pembroke-Mendip anticline, and that to the south of this anticline the Palæozoic floor is probably composed of pre-Coal-Measure rocks.

The discussion elicited by these two papers was scarcely worthy of the subject, perhaps from the matter having lost its freshness through so much having been written upon it.

At the same meeting Mr. W. Gibson, of H.M. Geological Survey, contributed a short account of the results of his investigations among the Upper Carboniferous rocks of North Staffordshire, which have an important bearing upon the question of the coal-fields lying concealed beneath the Red Rocks of the Midland counties. Mr. Gibson showed that considerable areas of so-called Permian rocks in the region which he has examined are conformable to the Upper Carboniferous strata and cannot be separated from them. By working out the details of these strata he has been able to detect true Upper Coal-Measures farther westward than has hitherto been done, and has found evidence that on the north-west side of the North Staffordshire anticline the valuable coal-measures and ironstones do not uninterruptedly descend beneath the so-called Permian, but rise locally westward and are nearer the surface than might have been expected.

Another paper of stratigraphical interest was that of Mr. A. J. Jukes-Browne on a recent boring through the Chalk and Gault near Dieppe, which shows that the Folkestone and Wissant facies of the Gault extend southward as far as Dieppe, a distance of about fifty-two miles.

Owing to the lantern being available on two days only during the meeting, viz. on Friday and Monday, it became necessary to take all papers requiring this method of illustration on these days, and the usual grouping of the contributions according to subject was, in consequence, only partially possible. At Friday's session Dr. A. W. Rowe gave an account of the methods by which he has attained such magnificent results in the photo-micrography of opaque objects, illustrating his address by a representative series of views to demonstrate the value of this mode of research in the study of the minute structure of fossils. Dr. G. Abbott then discussed the formation of concretions; and Dr. H. J. Johnston-Lavis dealt with that thorny question the origin of oolitic structure, renewing the debate begun last year at Bristol and strongly combating Mr. Wethered's view that the structure was originally organic. Unfortunately, Mr. Wethered was not present to sustain his case, but there was nevertheless an instructive discussion. Prof. W. J. Sollas in a short note on a cognate subject, the origin of flint, stated that he had recently found the hollow casts of sponge-spicules in abundance in the chalk in the vicinity of bands of flint both in Oxfordshire and on the Kentish coast, thus sustaining the view that the silica of the nodules was derived from this source.

Mr. E. Greenly described at this session some remarkable funnel-shaped pipes of hard sandstone in the Carboniferous Limestone of Dwlbau Point, East Anglesey, due to contemporaneous erosion of an exceptional kind; and he also gave an account of the glacial phenomena of the same locality. Prof. P. F. Kendall had an excellent paper on extra-morainic drainage in Yorkshire, in which he claimed that numerous abnormal valleys in the Eastern Moorlands and in the hills west of the Vale of York must have been excavated by the drainage of lakes formed at the margin of the ice-sheet during the glacial period; and Mr. J. Lomas put forward some new ideas respecting the formation of lateral moraines and rock-trains in glaciers.

On Saturday, as already mentioned, the president delivered his address, which constituted the only business of the Section.

On Monday a long list of papers was taken, including several with lantern illustration. Prof. Sollas discussed Homotaxy and Contemporaneity, showing that Huxley's well-known contention could not be sustained and had led to much misunderstanding of the value of fossil evidence. Prof. W. W. Watts briefly described a smoothed and grooved surface of Mount Sorrel Granite underlying undisturbed Keuper Marl, and his paper led to one of the best discussions of the meeting as to the climatal conditions of Triassic times, most of the speakers agreeing that the surface in question had probably been worn by wind-driven sand, and that it afforded further evidence of desert conditions during the period. Another short paper of high importance was that of Prof. A. Renard on the origin of Chondritic Meteorites, in which it was shown that the rock-structure of certain of these extra-terrestrial fragments presented the familiar phenomena of dynamo-metamorphism. As the president remarked in the discussion, it is not often that the geologist can apply the principles of his science beyond the sphere he inhabits.

The local effects of coast-erosion were next described and well illustrated by Captain McDakin and Mr. G. Dowker, after which Mr. W. Whitaker presented the first fruits of the efforts recently made by the Council of the Association to obtain from the coastguards all round our shores, with the sanction of the Lords of the Admiralty, schedules of information as to the changes due to the action of the sea.

Mr. Vaughan Cornish then exhibited a series of photographs of Wave-phenomena, and discussed the relations between wave-forms in different substances, a discussion which was renewed at a later session. The eruption of Vesuvius in 1898 was described and illustrated by Dr. Tempest Anderson; while Prof. G. Platania contributed an account of the recent volcanic phenomena of Mount Etna; and an excellent day's work was concluded by a report by Prof. P. F. Kendall on the results obtained by a local committee, by the use of chemical reagents, as to the flow of underground waters in the limestone district of Craven in Yorkshire at the sources of the Aire. A committee of the Association was formed to continue these researches, and a grant of 50*l.* was obtained in aid of the expenses.

The first paper taken on Tuesday was that of Prof. W. Boyd Dawkins on the geology of the Channel Tunnel, in which, after indicating the conditions under which the proposed tunnel would have been made, it was stated that in the portion 2300 yards long already excavated on the English side, the Lower Grey Chalk was soft enough to be easily cut by machine and hard enough to stand without lining, and that five years' exposure had not sensibly affected its cut surface. It was generally conceded by the speakers in the subsequent discussion that the geological conditions were peculiarly favourable for the construction of the tunnel, and that, apart from the political question, no insuperable difficulty was likely to be encountered.

Mr. F. W. Harmer then read a carefully prepared paper on a proposed new classification of the Pliocene deposits of the east of England, in which he suggested the terms *Lenhamian* for the Lenham Beds, *Gedgravian* for the Coralline Crag, *Waltonian*, *Newbournian* and *Butleyan* for different portions of the Red Crag, *Icenian* for the Norwich Crag, and *Chillesfordian* and *Weybournian* respectively for the Chillesford and Weybourne deposits. The author considers the Red Crag to have accumulated in shallow inlets which were silted up one after another during a slow upheaval of the southern part of the area. In a

second paper Mr. Harmer discussed the meteorological conditions of North-western Europe during the Pliocene and Glacial periods, finding in the early glaciation of Scandinavia, and the consequent establishment of anticyclonic conditions over that area, a probable solution of the change in the direction of the prevalent winds which he believes to be necessary to account for the accumulation of the crag-deposits on our eastern coast.

A short paper by Rev. J. M. Mello on some palæolithic implements of North Kent, and the exhibition on behalf of Mr. B. Harrison of a collection of "eoliths" from the neighbourhood of Ightham, led to a brisk discussion, in which Sir John Evans, Prof. Boyd Dawkins and other speakers denied that the so-called "eolithic implements" showed proof of human workmanship, while Prof. T. Rupert Jones stated Mr. Harrison's view of the case and was supported by Mr. Allen Brown.

The chief paper of the final session on Wednesday was that of Mrs. M. M. (Ogilvie) Gordon on sigmoidal curves in the earth's crust. This admirably rendered discourse was supplementary to the work recently published by Mrs. Gordon in the *Quarterly Journal of the Geological Society* and in NATURE, and had for its object the general statement of the phenomena which are presented when rock-folds in two directions intersect each other and produce "crust-torsion," with particular reference to the earth-forms which have been thus produced in the Alpine mountain-system. The complexity of the subject seemed to daunt most of the speakers in the discussion; but Prof. Lapworth pointed out how well the results of Mrs. Gordon's field-work agreed with the theoretical deductions to be drawn from the study of intercrossing earth-waves.

As usual, some of the most solid work of the Section was embodied in the reports of the committees of research which were presented during the meeting, but of which lack of space forbids more than the bare mention. Among these were the reports presented by Prof. A. P. Coleman on Interglacial Beds in Canada; by Mr. P. M. C. Kermode on the Deposits containing Elk remains in the Isle of Man; by Prof. P. F. Kendall on Erratic Blocks; by Rev. G. C. H. Pollen on the Ty Newydd Caves; by Mr. H. Bolton on the Uphill Caves; and by Prof. W. W. Watts on Geological Photographs.

Short afternoon excursions, which have become an established feature of the Section's arrangements, were made during the week to the Ropersole Coal Boring, to the colliery works under Shakespeare Cliff, to the East Cliff and St. Margaret Bay, and to the Warren at Folkestone.

To sum up the proceedings of the week—the sessions of the Section were well attended throughout, and the papers, though without any especially salient features, maintained a good average both in numbers and quality. Some palæontological papers which might have found place in the Section were taken in Sections D and K, and this branch of geological science was in consequence scantily represented in the list.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—Mr. W. L. H. Duckworth has been appointed to the University lectureship in physical anthropology.

Mr. R. G. K. Lempfert has been appointed Assistant Demonstrator in Experimental Physics.

It is proposed that McGill University, Montreal, be adopted as an institution affiliated to the University.

A NEW technical institute is to be erected, at a cost of 8450*l.*, in Carisbrooke Road, Liverpool.

THE sum of 25,000 dollars has been promised to Vassar College towards a biological laboratory on condition that an equal amount be raised for the same purpose by other means.

THE foundation-stone of a new technical college for Sunderland has just been laid. The college is to cost 25,000*l.*, and will, it is hoped, eventually be affiliated to Durham University.

DR. C. B. DAVENPORT, of Harvard University, has been appointed professor of zoology at the University of Chicago, in the place of Prof. Wheeler, who has gone to the University of Texas.

MR. H. B. KNOWLES has been appointed principal of the Swindon and North Wilts Technical School. Hitherto he has been teacher of physics and electrical engineering at the Bradford Technical School.

THE Technical Instruction Committee of the West Riding (Yorks.) County Council have consented to financially assist the managers of the district technical schools in forming reference libraries on the subjects of local instruction.

MR. EMERSON E. MCMILLIN has given the Ohio Academy of Science 250 dollars with which to carry on scientific investigations, and declared his intention of giving a similar amount annually if the money is wisely expended.

DARTMOUTH (U.S.A.) COLLEGE has recently received from Mr. E. Tuck, of New York, 300,000 dollars, to be used for the purposes of instruction, and Tuft's College has had bequeathed to it the sum of 60,000 dollars by the late Mrs. M. D. Goddard, of Newton, Mass.

THE regents of the University of California have accepted the plans designed by M. Bénard, of Paris, for their new university buildings, and some of the buildings will, it is stated, be begun next spring. The movement, as will be remembered, is mainly due to the generosity of Mrs. Phœbe A. Hearst.

AT a meeting held at Newcastle on Monday last, it was decided to make an effort to raise funds for the completion of the buildings in connection with the Durham University College of Science. Subscriptions amounting to 9500*l.* were promised at the meeting, and the sum of 100,000*l.* will, it is hoped, be raised by the end of the year.

IN connection with the Liverpool University College, Mr. W. Rathbone has made provision for the award annually of a Rathbone medal to the most distinguished third-year student. Mrs. George Holt and Miss Emma Holt (to whom the College has on more than one former occasion been much indebted) have each given the sum of 5000*l.* towards the physical laboratories of the institution.

AMONG recent appointments abroad we notice the following:—Dr. S. Avery to be professor of chemistry in the University of Idaho; Mr. H. B. Ward to be professor of zoology at Nebraska University; Mr. P. Field to be professor of mathematics in Carthage College; Dr. E. O. Sisson to be director of the histological laboratory in the recently consolidated medical schools of Keoduk, Iowa.

WITH reference to a recent note in this column respecting the admission of women students to the course of study at the Owens College which would qualify them for medical degrees and practice, we are requested to state that the resolution in favour of the course adopted was carried by a majority of nineteen, the voting being twenty-one for the resolution and two against it.

THE promoters of the Birmingham University scheme have recently received the munificent donation of 20,000*l.* from Mr. Charles Holcroft, and a number of large sums from other gentlemen, which bring the total amount promised to upwards of 315,400*l.* The total of over 300,000*l.* having been reached, the committee have secured the last 12,500*l.* which was offered by the friend of Mr. Joseph Chamberlain who prefers to remain anonymous.

SCIENTIFIC SERIAL.

American Journal of Science, October.—Explosive effect of electrical discharges, by J. Trowbridge, T. C. McKay, and J. C. Howe. The authors investigated the sudden increase of pressure in the gas, through which the discharge passes, by means of a vacuum tube provided with a manometer gauge. When spark-gaps up to 50 cm. were employed, with a maximum difference of potential of three million volts, they found that the explosive effect increased closely in proportion to the length of the spark, and began to diminish when the spark was longer than 50 cm. The air itself then becomes a fairly good conductor, and is strongly ionised.—Colour vision and the flicker photometer, by O. N. Rood. The author's flicker photometer reveals the fact that the curve of colour vision is not the same in any two persons supposed to have normal sight. Among five persons capable of sustaining Holmgren's worsted test, differences of colour values ranging from 1 to 14 per cent. were found.—Iodometric determination of gold, by F. A. Gooch and F. H. Morley. The authors investigate the effect upon the immediate evolution of iodine brought about by adding varying amounts of water to the gold solution before introducing the

iodide, and the effect of different amounts of iodide at different ilutions.—Mineralogical structure and chemical composition of he Trap of Rocky Hill, N.J., by A. H. Phillips. The Rocky Hill trap, from its holocrystalline nature, would be classed as a dolerite. From the character of the decomposition of the olivine, and the solution cavities in the diallage crystals, the intrusive nature of this dike is evident, as it must have been formed at a considerable depth below the surface and under very heavy pressure.—Some analyses of Italian volcanic rocks, by H. S. Washington. This paper deals with the composition of trachytes of the Phlegrean Fields and of Ischia. There are three parallel volcanic lines in the Italian district. The latest, along the peninsula, is characterised chiefly by high K_2O, by high CaO, and the presence of leucite. The next, that of the islands along the west coast, is high in alkalis, but with Na_2O rather higher than K_2O, and without leucite. The third, which lies far out in the Mediterranean, and which is possibly the oldest, is much higher in soda, and seems to be characterised by the presence of peculiar soda minerals such as enigmatite and æginine, nepheline also occurring in places.—Thermo-electricity in certain metals, by L. Holborn and A. L. Day. This is an English version of the author's Reichsanstalt paper on the gas thermometer.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, October 9.—M. van Tieghem in the chair.—On the elastic equilibrium of a rectangular plate, by M. Maurice Lévy.—Some remarks on double integrals of the second species in the theory of algebraic surfaces, by M. Émile Picard.—On a modification of Bessel's method for calculating occultations, by M. L. Cruls. In the modification suggested use is made of the time of apparent conjunction of the two stars. The advantage resulting from this method is twofold: it gives by a single calculation a precision generally only obtainable by a second approximation, and lends itself easily to a graphical construction and a simple geometrical interpretation of the different elements upon which the conditions of the phenomenon depend.—Observations of the Giacobini Comet (1889 *e*) made at the Observatory of Besançon, by M. P. Chofardet. The observations were made on the nights of October 3 and 4. The comet had the appearance of a nebulous sphere, 1′ in diameter, and having a slight nucleus of about the 13th magnitude.—On fundamental functions and on the development of a holomorphic function at the interior of a contour in a series of fundamental functions, by M. Renaux.—On the stereochemistry of nitrogen, by M. J. A. Le Bel. The author replies to various criticisms by van 't Hoff, Markwald and others on his work published in 1891 on the preparation of active compounds from methyl- ethyl- propyl-isobutylammonium chloride, and lays down the exact experimental conditions necessary to repeat his results. The conclusion is drawn that there can now be no doubt as to the optical isomerism existing in the derivatives of ammonium chloride containing four different radicles, and containing at least ten atoms of carbon. It is also established that with derivatives less rich in carbon the stability of these optical isomerides is diminished.—On the reversible liquefaction of albuminoids, by M. Tsvett. It is known that the solution of albuminoids is favoured by certain acids, alkalis, and salts. The author has found that certain organic substances, such as resorcinol, pyrocatechol, phenol, chloral hydrate, &c., possess this liquefying property to a very marked extent. Thus a solution of gelatine treated with an eighty per cent. aqueous solution of resorcinol, forms two liquid layers, the upper a solution of gelatine in aqueous resorcinol, the lower a solution of aqueous resorcinol in gelatine, the coefficients of reciprocal solubility varying with the concentration of the resorcinol and the temperature. The phenomenon appears to be truly reversible.—On the volumetric estimation of quinones derived from benzene, by M. Amand Valeur. The quinones are reduced by a mixture of potassium iodide and hydrochloric acid, and the liberated iodine titrated with sodium thiosulphate. Experiments were carried out with quinone, dichloroquinone, toluquinone, and thymoquinone; the results are quite satisfactory, and are very rapidly obtained.—On the structure of the nucleus in the myelocytes of Gasteropods and Annelids, by M. Joannes Chatin. The myelocytes of these invertebrates, contrary to the usual statements, may show a very clear, nuclear membrane.—On the alternation of generations in *Cutleria*, by M. C. Sauvageau.—On a gutta-percha plant capable of being cultivated in a temperate climate, by MM. Dybowski and G. Fron. The authors have extracted gutta-percha from the fresh leaves of *Eucomia ulmoïdes*. This plant can be grown in temperate climates, and experiments were carried out as to the best mode of multiplication of the plant. It is easy to obtain good seeds in large quantity, but their germination is difficult and capricious. Propagation through cuttings, however, offers no difficulties, the slips taking root easily and developing vigorously.—Action of anæsthetic vapours upon the vitality of dry and moist seeds, by M. Henri Coupin. The vitality of dry seeds is unaffected even by saturated ether and chloroform vapours; but with moist seeds the case is quite different, the presence of only 3·7 c.c. of ether in 10 litres of air being sufficient to kill the seed.

DIARY OF SOCIETIES.

THURSDAY, OCTOBER 19.

CAMERA CLUB, at 8.15.—Clouds and Photographic Landscapes: J. Cadett.

TUESDAY, OCTOBER 24.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Wellington Film: Harry Wade.

FRIDAY, OCTOBER 27.

PHYSICAL SOCIETY, at 5.—The Magnetic Properties of the Alloys of Iron and Aluminium: Dr. S. W. Richardson.—Exhibition of a Model illustrating a Number of the Actions in the Flow of an Electric Current: G. L. Addenbrooke.—Repetition of some Experiments with the Wehnelt Interrupter devised by Prof. Lecher: W. Watson

INSTITUTION OF MECHANICAL ENGINEERS, at 7.30.—The Incrustation of Pipes at Torquay Water Works: William Ingham.—A Continuous Mean-Pressure Indicator for Steam Engines: Prof. William Ripper.

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OFFICE: ST. MARTIN'S STREET, LONDON, W.C.

Printed by RICHARD CLAY & SONS, LTD., at 7 & 8 Bread Street Hill, Queen Victoria Street, in the City of London.